

NATURAL RESOURCES SECTION
OF THE
RESOURCES MANAGEMENT PLAN

GOLDEN GATE NATIONAL RECREATION AREA

Prepared

by

Golden Gate National Recreation Area
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1 INTRODUCTION

Golden Gate National Recreation Area (GGNRA) was created from a vision to protect and promote the enjoyment of the natural and cultural resources on the edge of the urban San Francisco Bay Area communities. The vast natural resources that existed in the bay estuary and its environs prior to 1800 have been reduced to minute remnants, which are protected in a handful of national, state and local parks and open space. The opportunity exists in GGNRA to preserve the last remnants of what was once an abundant flora and fauna.

This Natural Resources Management Plan documents the extent and condition of and threats to the natural resources of GGNRA, and lays a foundation for actions to preserve and restore, where necessary, the Californian habitats, and ecosystems on which they depend. It is complementary to and consistent with other National Park Service (NPS) and GGNRA management documents.

1.1 Purpose of Park Establishment

The National Park Service Act of 1916 created the NPS:

“ . . . to conserve the scenery and natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.”

GGNRA is administered by the NPS. One mandate for all national park units is to preserve natural resources values. GGNRA’s enabling legislation states that the park was founded:

“In order to preserve for public use and enjoyment certain areas of Marin and San Francisco possessing outstanding natural, historic, scenic and recreational values . . .”

The act stated that management of the park:

“ . . . shall utilize the resources in a manner which will provide for recreation and educational opportunities consistent with sound principles of land use planning and management.”

The act charges the Secretary to:

“ . . . preserve the recreation area, as far as possible, in its natural setting, and protect it from development and uses which would destroy the scenic beauty and natural character of the area.”

1.2 Purpose of the Plan

This Natural Resources Management Plan identifies GGNRA’s natural resources and their condition. It describes a program to preserve, monitor, maintain, and restore, where necessary, the natural California habitats, and ecosystems on which they depend. The ever-growing metropolitan population adjacent to these natural areas exerts a great pressure to over-utilize the fragile natural systems that remain. This plan identifies these pressures and provides strategies for protecting the natural systems and resources.

This plan is complementary to and consistent with other NPS and GGNRA management documents including the NPS Policies (1989), Statement for Management (1990), the General Management Plan (1980), and the Presidio General Management Plan (1994). This plan revises the previous Natural

Resources Management Plan (1994) and addenda (1982, 1984, 1987). The existing focused plans (Fire Management Plan, 1986; Water Resources Management Plan, 1991) were written as supplemental components of the 1994 Natural Resources Management Plan. The current plan is also consistent with the goals and objectives of the United Nations Man in the Biosphere program. GGNRA is a member of this program as part of the Central California Coast Biosphere Reserve.

1.3 Compliance/National Environmental Policy Act

Compliance with the National Environmental Policy Act (NEPA) and other resource protection legislation is not accomplished through the Natural Resources Management Plan. Each Project Statement includes a section on the need for compliance, or indicates whether a project is categorically excluded from the NEPA process. NPS guidelines for Resources Management Plans require that environmental compliance be undertaken when funding is likely. Environmental documents for appropriate projects will be completed prior to any irreversible or irretrievable commitment of funds or efforts to a particular course of action, beyond planning.

2 NATURAL RESOURCES VALUES

2.1 Geography, Geology and Minerals

GGNRA comprises approximately 75,000 acres of coastal lands in the San Francisco Bay Area. This long, narrow park is divided by the Golden Gate entrance to San Francisco Bay, which separates the northern Marin County lands from the southern San Francisco and San Mateo county lands.

The topographical relief of the park ranges from sea level to 2,300 feet above mean sea level near the top of Mt. Tamalpais. Hillslopes range from almost flat marine terraces and alluvial deposits to steep canyons along some creeks, and near vertical bluffs above some beaches. Most watersheds are less than one square mile in area, and flow through narrow V-shaped stream beds cut through bedrock. Stream channel gradients range from 3 percent, in Elk Creek, to 35 percent, in steep tributaries on Bolinas Ridge.

GGNRA is located in a seismically active zone. The San Andreas Fault extends northwest from near Fort Funston, and runs through Bolinas Lagoon and Tomales Bay. The San Andreas is the major fault in the area, but many smaller faults also exist. Movement on the San Andreas continues at an average of about 1 to 2 centimeters per year. This movement is expressed as a violent earthquake occurring about once a century. Many earthquakes of lesser magnitude occur along the length of the fault.

Bedrock parent materials within the park are jumbled, as a result of grinding movement along the San Andreas Fault. Sandstone, pillow basalts, shale, Chert, greenstone (basalt), serpentine, and metamorphic rocks are among the bedrock types present. These rocks belong to the Franciscan Assemblage and were originally deposited on the ocean floor 80 to 140 million years ago. The rocks were greatly deformed and partly metamorphosed as the ocean floor was thrust under the western edge of the North American Plate, resulting in a landscape of easily eroded, sheared and crushed sandstone and shale, with occasional blocks of more resistant rock forming prominent outcrops.

The Marin Headlands contains more resistant rocks than the more erodible Franciscan Melange found to the north of Pirates Cove. Radiolarian chert composed of fossilized radiolaria underlies about half of the Headlands, and because of its resistance to weathering, makes up nearly all the ridge tops and summits. The contorted layers in this chert express the plate-tectonic actions in this area and are frequently visited by geology classes. Topographically, melange areas have broader ridge crests and gentler slopes and contain more earthflows than the coherent Marin Headlands. Groundwater is close to the surface and frequently emerges as seeps or springs in the melange area.

Locally, especially in the southwest part of San Francisco, are younger rocks, soft sedimentary deposits that are less than two million years old. The sea cliffs at Fort Funston were formed from the oldest of these tilted fossil-rich beds of sand and clay (the Merced Formation), and are easily eroded by wave action. In the last few hundred thousand years, sand and clay have accumulated as beaches, dunes and nearshore deposits, and these are now exposed at Sutro Heights, Baker Beach, Angel Island and Rodeo Cove.

Many abandoned quarries are found within GGNRA. Dogtown Copper Mine, located just off Bolinas Ridge, is the only known mineral development in the park. It was developed in 1863 and re-worked around the turn of the century. Its two shafts are now abandoned.

With its diversity of rock types and active geologic processes, many of the park's outcrops and locations are commonly included in geologic field trips for college and university classes. These destinations include beaches, coastal bluffs, roadcuts and old quarries.

2.2 Water Resources

The Draft Aquatic/Water Resources Management Plan (GGNRA 1990) provides a description of the water resources found in the park. The varied water resources of the park include groundwater (springs), freshwater (streams and ponds), salt water (the Pacific ocean and San Francisco Bay), transitional areas (brackish lagoons), and seasonal wetlands. Eight significant watersheds are located within the park. They are, from north to south, Lagunitas Creek, Olema Creek, Redwood Creek, Elk Creek, Rodeo Creek, Lobos Creek, West Union Creek, and the San Francisco Watershed lands in San Mateo County. San Pedro Creek, a San Mateo County Park, is within the GGNRA's authorized boundary and is noted here because it is a significant creek with an annual steelhead trout migration.

The water in the GGNRA has many beneficial uses. These are documented by the Bay Area Regional Water Quality Control Board, and include municipal water supply, agricultural supply, fresh water replenishment, water contact and non-water contact recreation, commercial and sport ocean fishing, warm and cold fresh water habitat, terrestrial habitat, the preservation of rare and endangered species, fish migration and fish spawning, and shellfish harvesting. Eleven rare species are associated with GGNRA waters, including eight federally listed species: the California freshwater shrimp (*Syncaris pacifica*), tidewater goby (*Eucyclogobius newberryi*), red-legged frog (*Rana aurora draytonii*), Sacramento River winter-run chinook salmon (*Oncorhynchus tshawytscha*), steelhead trout (*Oncorhynchus mykiss*), coho salmon (*Oncorhynchus kisutch*), San Francisco garter snake (*Thamnophis sirtalis tetrataenia*), and Steller sea lion (*Eumetopias jubatus*).

2.3 Plant Resources

The park is located in the center of the California Floristic Province, one of only five regions in the world with a Mediterranean climate. Complex climatic and geological changes during the past millions of years have interacted to produce a diverse flora rich in endemic genera and species (Raven and Axelrod 1978). One center of endemism in California is the Tamalpais province, an area of high local diversity in soil types and climates (Stebbins and Major 1965, Raven and Axelrod 1978). The park and its neighboring parks contain much of the remaining wild lands of this Tamalpais province. Situated in the great mixing zone of the central California Coast Range, the park includes some species that reach their northern distributional limit as well as others that are at their southern limit; species with northern coastal affinities mingle with those of the southern interior (Howell 1970, Howell, Raven & Rubtzoff 1958).

More than 886 plant species and subspecies exist in the park. A systematic inventory of the park's flora would likely document many more species since most areas within the park have not been systematically surveyed by botanists for more than four decades.

The plant alliances and associations of the park are similarly diverse. An estimated 40 vegetation alliances and more than 60 vegetation associations, as defined in the California Native Plant Society Classification System (Sawyer and Keeler-Wolf 1995) occur in the park. They include such diverse alliances as California oat grass, purple needlegrass, Pacific reedgrass, chamise, leather oak, coffeeberry, blue-blossom, California bay, coast live oak, coast redwood, California buckeye and arroyo willow. They are also among those most threatened by changing land uses, including fire suppression, grazing, and recreational uses, and by the spread of non-native pest plant species.

2.4 Rare and Endangered Species

Thirty-three species in GGNRA are protected under the Endangered Species Act as amended (16 USC 1536 (a) (2) 1982) (Table 1). There are 69 rare or special status wildlife species currently identified as permanent or seasonal residents of the park, or dependent upon park lands and waters for migration. Of

these, 12 are listed as federally endangered, 12 are federally threatened, 1 is state endangered, 3 are state threatened, 31 are federal species of concern, and 10 are state designated species of special concern. Numerous other wildlife species (birds in particular) are considered sensitive by the Audubon Society, Partners in Flight, the California Department of Forestry, or are designated Migratory Nongame Birds of Management Concern by the U.S. Fish and Wildlife Service (USFWS). Nearly all of the native birds documented in the park are protected under the Migratory Bird Treaty Act (16 USC 528-531).

Thirty-eight rare or special status plant species are currently identified within GGNRA. Of those species, 9 are Federally Endangered, 1 is Federally Threatened, 13 are Federal Species of Concern, and the remaining 15 species are included or proposed for inclusion by the California Native Plant Society. GGNRA has adopted the policy that all special status plant species be afforded the full protection of the Endangered Species Act.

2.5 Wildlife Resources

The park's diverse habitats support a rich assemblage of wildlife. At least 387 vertebrate species are known to occur within the park boundaries. Species lists compiled from a variety of sources and incomplete inventories include 11 amphibians, 20 reptiles, 53 fish, 53 mammals, and 250 birds (ICE 1999). Terrestrial invertebrates in the park are less well known, with the exception of butterflies at two areas of the park, Marin Headlands and Milagra Ridge, which support diverse butterfly populations.

Wildlife habitats within the park range from introduced eucalyptus and closed-cone Monterey pine and cypress forests, to hardwood, mixed evergreen, Douglas fir, redwood and riparian forests, to coastal scrub, annual and perennial grasslands, freshwater and saline wetlands and wet meadows, as well as estuarine, lacustrine, marine and riverine aquatic habitats. In addition, barren coastal cliffs and islands, and the escaped ornamental gardens of Alcatraz provide habitat for a variety of species.

Alcatraz Island supports regionally significant populations of colonial nesting waterbirds in one of the most internationally visible settings within the NPS. Alcatraz receives 1.4 million national and international visitors each year. The "evolution" of the island's landscape of crumbling ruins and abandoned, overgrown gardens, where natural processes predominate in a manmade environment, has fostered the recent increase in diversity and abundance of colonial waterbirds on the island. Today, the island supports the most diverse assemblage of marine and estuarine colonial nesting waterbirds in San Francisco Bay and some of the most significant wildlife resources within the GGNRA. As many as 4,500 adults and chicks of seven colonial nesting species may inhabit the island during the nesting season.

The island's black-crowned night-heron colony (*Nycticorax nycticorax*) is one of the largest in the greater San Francisco Bay region. The island supports San Francisco Bay's only colonies of Brandt's cormorant (*Phalacrocorax penicillatus*), pelagic cormorant (*Phalacrocorax velagicus*), and pigeon guillemots (*Cephus columba*). These species usually breed along the outer coast and on offshore islands. The western gull (*Larus occidentalis*) colony represents a significant portion of its coastal breeding population in northern California. Alcatraz is the only San Francisco Bay island with large

Table 1. Special Status Species of Golden Gate National Recreation Area May 1999

COMMON NAME	SCIENTIFIC NAME	Federal	State	Other	IUCN	NDDB Rank
Invertebrates						
Xerces blue butterfly	<i>Glaucopsyche xerces</i>			Extinct		
Sthenele satyr	<i>Cercyonis sthenele sthenele</i>			Locally extirpated		
Mydas fly				Of local concern: Presidio is only known location		
California freshwater shrimp*	<i>Syncaris pacifica</i>	FE	SE		EN	G1S1
Mission blue butterfly*	<i>Icaricia icarioides missionensis</i>	FE			NE	G5T2S2
San Bruno elfin butterfly*	<i>Incisalia mossi bayensis</i>	FE			NE	G4T1S1
Bay checkerspot butterfly*	<i>Euphydryas editha bayensis</i>	FT			NE	G5T2S2
California floater (mussel)*	<i>Anodonta californiensis</i>	FSC			NE	G?S2?
Tomales asellid*	<i>Caecidotea tomalensis</i>	FSC				G2S2
Sandy beach tiger beetle	<i>Cicindela hirticollis grvida</i>	FSC				G5T4S1
Globose dune beetle*	<i>Coelus globosus</i>	FSC			VU	G1S1
Ricksecker's water scavenger beetle	<i>Hydrochara rickseckeri</i>	FSC			NE	G1G2S1S2
Bumblebee scarab beetle	<i>Lichnanthe ursina</i>	FSC			NE	G2S2
Opler's longhorn moth	<i>Adela oplerella</i>	FSC				G?S?
Marin elfin butterfly	<i>Incisalia mossii</i> ssp. 2	FSC				G4T?S?
Mammals						
Pronghorn antelope	<i>Antilocapra americana</i>			Locally extirpated		
Tule elk	<i>Cervus elaphus</i>			Locally extirpated		
Grizzly bear	<i>Ursus arctos</i>			Locally extirpated		
Salt marsh harvest mouse*	<i>Reithrodontomys raviventris</i>	FE	SE	DFG:Fully protected	VU	G1G2S1S2
Northern (Steller) sea lion	<i>Eumetopias jubatus</i>	FT			EN	G3S2
Southern sea otter	<i>Enhydra lutris nereis</i>	FT		DFG:Fully protected		G4T1S1
Humpback whale	<i>Megaptera novaeangliae</i>	FE				
Pacific western big-eared bat*	<i>Corynorhinus townsendii townsendii</i>	FSC	CSC		VU	G5T3T4S2S3
Long-eared myotis bat	<i>Myotis evotis</i>	FSC				G5S4?
Fringed myotis bat	<i>Myotis thysanodes</i>	FSC				G5S4
Long-legged myotis bat	<i>Myotis volans</i>	FSC				G5S4?
Yuma myotis bat*	<i>Myotis yumanensis</i>	FSC	CSC			G5S4?
Greater western mastiff-bat	<i>Eumops perotis californicus</i>	FSC	CSC			G5S3?

COMMON NAME	SCIENTIFIC NAME	Federal	State	Other	IUCN	NDDB Rank
San Francisco dusky-footed woodrat*	<i>Neotoma fuscipes annectens</i>	FSC	CSC		DD	G5T2T3S2S3
Point Reyes jumping mouse*	<i>Zapus trinotatus orarius</i>	FSC	CSC		LR	G5T2?S2?
Pallid bat	<i>Antrozous pallidus</i>		CSC			G5S3
Fishes						
Coho salmon — Central California Coast ESU*	<i>Oncorhynchus kisutch</i>	FT				G5S2?
Chinook salmon — Sacramento River winter run	<i>Oncorhynchus tshawytscha</i>	FE	SE			G5S1
Chinook salmon — Central Valley fall/late fall-run ESU		FPT				
Chinook salmon — Central Valley spring-run ESU	<i>Oncorhynchus tshawytscha</i>	FPE	ST	FS:Sensitive		G5S1
Steelhead — Central California Coast ESU*	<i>Oncorhynchus mykiss</i>	FT				G5S2
Steelhead — Central Valley ESU	<i>Oncorhynchus mykiss</i>	FT				G5S2
Tidewater goby*	<i>Eucyclogobius newberryi</i>	FE	CSC		VU	G2G3S2S3
Pacific lamprey*	<i>Lampetra tridentata</i>	FSC				G5S5
Green sturgeon*	<i>Acipenser medirostris</i>	FSC	CSC		VU	G4G5S1S2
Tomales roach*	<i>Lavinia symmetricus</i> ssp. 2		CSC			G5T2T3S2S3
Amphibians						
California red-legged frog*	<i>Rana aurora draytonii</i>	FT	CSC	DFG:Protected		G4T2T3S2S3
Foothill yellow-legged frog*	<i>Rana boylei</i>	FSC	CSC	DFG:Protected	NE	G3S2S3
Northern red-legged frog*	<i>Rana aurora aurora</i>	FSC	CSC	DFG:Protected		G4T2?S2?
Reptiles						
San Francisco garter snake*	<i>Thamnophis sirtalis tetrataenia</i>	FE	SE	DFG:Fully protected	NE	G5T2S2
Northwestern pond turtle*	<i>Clemmys marmorata marmorata</i>	FSC	CSC	DFG:Protected FS:Sensitive		G4T4S3
Southwestern pond turtle	<i>Clemmys marmorata pallida</i>	FSC	CSC	DFG:Protected		G4T2T3S2
California horned lizard	<i>Phrynosoma coronatum frontale</i>	FSC	CSC	DFG:Protected		G4T3T4S3S4
Birds						
California brown pelican	<i>Pelecanus occidentalis californicus</i>	FE	SE	FWS:MNBMC DFG:Fully protected		G4T3S1S2
Bald eagle	<i>Haliaeetus leucocephalus</i>	FPD	SE	CDF:Sensitive DFG:Fully protected		G4S2
American peregrine falcon*	<i>Falco peregrinus anatum</i>	FPD	SE	FWS:MNBMC DFG:Fully protected CDF:Sensitive		G3T2S2
Western snowy plover	<i>Charadrius alexandrinus nivosus</i>	FT	CSC	FWS:MNBMC		G4T2S2

COMMON NAME	SCIENTIFIC NAME	Federal	State	Other	IUCN	NDDB Rank
California least tern	<i>Sterna antillarum browni</i>	FE	SE	FWS:MNBMC DFG:Fully protected		G4T2T3S2S3
Marbled murrelet*	<i>Brachyramphus marmoratus</i>	FT	SE	FWS:MNBMC CDF:Sensitive	LR	G3S1
Northern spotted owl*	<i>Strix occidentalis caurina</i>	FT		FWS:MNBMC CDF:Sensitive	LR	G3T2T3S2S3
Swainson's hawk	<i>Buteo swainsoni</i>		ST			G4S2
California black rail*	<i>Laterallus jamaicensis coturniculus</i>	FSC	ST	FWS:MNBMC DFG:Fully protected WatchList:CA/National		G4T1S1
Willow flycatcher	<i>Empidonax traillii</i>		SE	FS:Sensitive		G5S1S2
Bank swallow*	<i>Riparia riparia</i>		ST			G5S2S3
Harlequin duck	<i>Histrionicus histrionicus</i>	FSC	CSC			G5S2
Ferruginous hawk	<i>Buteo regalis</i>	FSC	CSC			G4S3S4
Elegant tern	<i>Sterna elegans</i>	FSC	CSC	FWS:MNBMC	LR	G5S1
Western burrowing owl	<i>Athene cunicularia hypugea</i>	FSC	CSC	FWS:MNBMC		G4T2S2
Loggerhead shrike*	<i>Lanius ludovicianus</i>	FSC	CSC	FWS:MNBMC		G4S4
Tricolored blackbird	<i>Agelaius tricolor</i>	FSC	CSC	FWS:MNBMC		G2S2
Bell's sage sparrow*	<i>Amphispiza belli belli</i>	FSC	CSC	FWS:MNBMC WatchList:National		G5T2?S2?
Saltmarsh common yellowthroat*	<i>Geothlypis trichas sinuosa</i>	FSC	CSC	Calif PIF Riparian SCP		G5T2S2
Great egret (rookery)*	<i>Ardea alba</i>			CDF:Sensitive		G5S4
American bittern*	<i>Botaurus lentiginosus</i>			FWS:MNBMC		G5S3
White-tailed kite (nesting)*	<i>Elanus leucurus</i>			FWS:MNBMC DFG:Fully protected		G5S3
Cooper's hawk*	<i>Accipiter cooperi</i>		CSC			G4S3
Sharp-shinned hawk*	<i>Accipiter striatus</i>		CSC			G4S3
Golden eagle*	<i>Aquila chrysaetos</i>		CSC	DFG:Fully protected CDF:Sensitive		G4S3
Northern harrier*	<i>Circus cyaneus</i>		CSC	FWS:MNBMC		G5S3
Osprey*	<i>Pandion haliaetus</i>		CSC			G5S3
Merlin	<i>Falco columbarius</i>		CSC			G5S3
Vaux's swift	<i>Chaetura vauxi</i>		CSC	FWS:MNBMC		G?S3
California horned lark*	<i>Eremophila alpestris actia</i>		CSC			G4G5T3S3
Purple martin*	<i>Progne subis</i>		CSC			G5S3

COMMON NAME	SCIENTIFIC NAME	Federal	State	Other	IUCN	NDDB Rank
Yellow warbler*	<i>Dendroica petechia brewsteri</i>		CSC			G5T2S2
Brandt's cormorant*	<i>Phalacrocorax penicillatus</i>			WatchList:CA		
Black oystercatcher*	<i>Haematopus bachmani</i>			WatchList:CA/National		G5S2
Long-billed curlew	<i>Numenius americanus</i>			WatchList:CA/National		
Western gull*	<i>Larus occidentalis</i>			WatchList:CA		
California quail*	<i>Callipepla californica</i>			WatchList:CA		
Band-tailed pigeon*	<i>Columba fasciata</i>			Only 2 SF locations		
				WatchList:Local/ National		
Rufous hummingbird	<i>Selasphorus rufus</i>			WatchList:CA/National		
Allen's hummingbird*	<i>Selasphorus sasin</i>			WatchList:CA/National		
Nuttall's woodpecker*	<i>Picoides nuttallii</i>			WatchList:CA/National		
Olive-sided flycatcher*	<i>Contopus borealis</i>			FWS:MNBMC		G?S4
				WatchList:CA		
Pacific-slope flycatcher*	<i>Empidonax difficilis</i>			FWS:MNBMC		
				WatchList:CA		
Warbling vireo*	<i>Vireo gilvus</i>			FWS:MNBMC		
				Calif PIF Riparian SCP		
Chestnut-backed chickadee*	<i>Poecile rufescens</i>			WatchList:Local		
Swainson's thrush*	<i>Catharus ustulatus</i>			Calif PIF Riparian SCP		
California thrasher*	<i>Toxostoma redivivum</i>			WatchList:CA/National		
Black-throated gray warbler*	<i>Dendroica nigrescens</i>			WatchList:CA		
Hermit warbler*	<i>Dendroica occidentalis</i>			WatchList:CA/National		G4G5S3?
				FWS:MNBMC		
MacGillivray's warbler*	<i>Oporornis tolmiei</i>			WatchList:Local		
Lark sparrow*	<i>Chondestes grammacus</i>			FWS:MNBMC		
Song sparrow*	<i>Melospiza melodia</i>			Calif PIF Riparian SCP		
Black-headed grosbeak*	<i>Pheucticus melanocephalus</i>			Calif PIF Riparian SCP		
Western screech owl*	<i>Otus kennicottii</i>			Of local concern:		
				Presidio only remaining		
				SF County location		
Wrentit*	<i>Chamaea fasciata</i>			Of local concern:		
				Presidio only remaining		
				SF County location		

COMMON NAME	SCIENTIFIC NAME	Federal	State	Other	IUCN	NDDB Rank
Plants						
Raven's manzanita	<i>Arctostaphylos hookeri</i> ssp. <i>ravenii</i>	FE	SE	CNPS 1B		
Tiburon Indian paintbrush	<i>Castilleja affinis</i> ssp. <i>neglecta</i>	FE	ST	CNPS 1B		
Fountain thistle	<i>Cirsium fontinale</i> ssp. <i>fontinale</i>	FE	SE	CNPS 1B		
Presidio clarkia	<i>Clarkia franciscana</i>	FE	SE	CNPS 1B		
San Mateo wooly sunflower	<i>Eriophyllum latilobum</i>	FE	SE	CNPS 1B		
San Francisco lessingia	<i>Lessingia germanorum germanorum</i>	FE	SE	CNPS 1B		
Santa Cruz island bush mallow	<i>Malacothamnus fasciculatus</i> var. <i>nesioticus</i>	FE	SE	CNPS 1B		
White-rayed pentachaeta	<i>Pentachaeta bellidiflora</i>	FE	SE	CNPS 1B		
San Mateo thornmint	<i>Acanomintha ovata</i>	FE	SE	CNPS 1B		
Marin dwarf flax	<i>Hesperolinon congestum</i>	FT	ST	CNPS 1B		
Mason's ceanothus	<i>Ceanothus masonii</i>	FSC	ST			
Coast rock cress	<i>Arabis blepharophylla</i>	FSC		CNPS 4		
Montara manzanita	<i>Arctostaphylos montaraensis</i>	FSC		CNPS 1B		
Marin manzanita	<i>Arctostaphylos virgata</i>	FSC		CNPS 1B		
San Mateo tree lupine	<i>Lupinus eximius</i>	FSC		CNPS 3		
Delores campion	<i>Silene verecunda</i>	FSC		CNPS 1B		
Santa Cruz microseris	<i>Stebbinsoseris decipiens</i>	FSC		CNPS 1B		
Tamalpais jewelflower	<i>Streptanthus glandulosus</i>	FSC		CNPS 1B1		
San Francisco owl's clover	<i>Triphysaria floribunda</i>	FSC		CNPS 1B		
California bottle-brush grass	<i>Elymus californicus</i>	FSC		CNPS 4		
Tiburon buckwheat	<i>Eriogonum luteolum</i> var. <i>caninum</i>	FSC		CNPS 3		
San Francisco wallflower	<i>Erysimum franciscanum</i>	FSC		CNPS 4		
Fragrant fritillary	<i>Fritillaria liliacea</i>	FSC		CNPS 1B		
San Francisco gumplant	<i>Grindelia hirsutula</i>	FSC		CNPS 1B		
Wedge-leaved horkelia	<i>Horkelia cuneata</i> var. <i>sericea</i>	FSC		CNPS 1B		
Dune gilia	<i>Gilia capitata</i> ssp. <i>chamissonis</i>	FSC		CNPS 4		
San Francisco spineflower	<i>Chorizanthe cuspidata</i>	FSC		CNPS 1B		
Point Reyes salt marsh bird's beak	<i>Cordylanthus maritimus</i> ssp. <i>palustris</i>	FSC		CNPS 1B		
Point Reyes ceanothus	<i>Ceanothus gloriosus gloriosus</i>			CNPS 4		
Glory brush	<i>Ceanothus gloriosus</i> var. <i>exaltatus</i>			CNPS 4		
Franciscan thistle	<i>Cirsium andrewsii</i>			CNPS 4		

COMMON NAME	SCIENTIFIC NAME	Federal	State	Other	IUCN	NDDB Rank
Western leatherwood	<i>Dirca occidentalis</i>			CNPS 1B		
Oakland star tulip	<i>Calochortus umbellatus</i>			CNPS 4		
Indian paintbrush	<i>Castilleja subinclusa</i> ssp. <i>franciscana</i>			CNPS 4		
Tamalpais manzanita	<i>Arctostaphylos hookeri</i> ssp. <i>montana</i>			CNPS 1B		
Choris' popcornflower	<i>Plagiobothrys chovisianus</i> var. <i>chorisianus</i>			CNPS 3		

KEY TO TABLE 1

* denotes species breeding within Golden Gate National Recreation Area

ESU = Evolutionarily Significant Unit

FEDERAL LISTING STATUS

FE = Federally Endangered

FPE = Federally Proposed Endangered

FT = Federally Threatened

FPT = Federally Proposed Threatened

FPD = Federal Proposed De-listed

FSC = Federal Species of Concern

STATE LISTING STATUS

SE = State Endangered

ST = State Threatened

CSC = California Species of Special Concern (California Department of Fish and Game 1998)

IUCN RED LIST CATEGORIES (International Union for the Conservation of Nature and Natural Resources and the World Conservation Monitoring Center 1994)

EN = Endangered, high risk of extinction in wild in near future

VU = Vulnerable, high risk of extinction in wild in medium-term future

LR = Lower Risk

DD = Data Deficient, inadequate information to make an assessment

NE = Not Evaluated

NDDB RANKS

California Natural Diversity Database Ranks are a shorthand formula on how rare a taxon is, both throughout its range and within California

Global Ranks: worldwide status of a full species: G1 to G5

G1 = extremely endangered: <6 occurrences, or <1,000

individuals, or 10,000 to 50,000 acres occupied

G2 = endangered: 6-20 occurrences, or 1,000-3,000

individuals, or 10,000 to 50,000 acres occupied

G3 = restricted range, rare: 21-100 occurrences, 3,000 to

10,000 individuals, or 10,000 to 50,000 acres occupied

G4 = apparently secure, some concerns such as narrow habitat or continuing threats

G5 = demonstrably secure, commonly found throughout its historic range

OTHER STATUS LISTINGS:

FWS = Migratory Nongame Birds of Management Concern (MNBMC) (U.S. Fish and Wildlife Service 1995)

FS: Sensitive, U.S. Forest Service, declining species

DFG: Protected and Fully Protected.

CNPS: California Native Plant Society status

1A = Presumed extinct in California

1B = Rare or endangered in California and elsewhere

2 = Rare or endangered in California, more common elsewhere

3 = Needs more information

4 = Plants have limited distribution

Watch List: CA/National and California - National Audubon Society

PIF: Partners-in-Flight

SCP: Species of Conservation Priority

CDF: California Department of Forestry

waterbird breeding colonies that is open to the public. Colonial nesting waterbirds are also considered important biological monitors of the health of estuarine ecosystems. They are high in the food web and may reflect contamination in a variety of ecosystem components. Hundreds of double-crested cormorants (*Phalacrocorax auritus*) also roost on the island during the non-breeding season.

A pair of Heerman's gulls (*Larus heermanni*) nested on Alcatraz in 1980. This was the first published account of Heerman's gulls ever nesting in the United States. Alcatraz represents the northernmost nesting record for this species, which usually nests in Mexico (Howell et al. 1983). Numerous species of landbirds also breed on Alcatraz, including Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos*), common mergansers (*Mergus merganser*), song sparrows (*Melospiza melodia*), white-crowned sparrows (*Zonotrichia leucophrys*), and common ravens (*Corvus corax*), among others.

Colonial Waterbirds on Alcatraz Island 1996-1998	Maximum Annual Count
Western gull (breeding since mid-1970s)	486 pairs
Black-crowned night-heron (breeding since mid-1970s)	341 pairs
Brandt's cormorant (breeding since 1991)	231 pairs
Pelagic cormorant (breeding since mid-1980s)	20 pairs
Pigeon guillemot (breeding confirmed 1982)	17 pairs
Snowy egret (breeding since 1997)	11 pairs
Great egret (bred 1995 to 1997)	2 pairs
Black oystercatcher (breeding confirmed 1995)	1 pair

One native amphibian, the California slender salamander (*Batrachoseps attenuatus*), and one native mammal, the deer mouse (*Peromyscus maniculatus*), also inhabit Alcatraz. A portion of the deer mouse population exhibits unusual coloring and may represent a morphologic or genetic trait unique to Alcatraz.

The park supports other small seabird colonies along coastal cliffs and offshore rocks. Bird Island in Marin County is one of the largest roosting sites in northern California for the endangered California brown pelican (*Pelecanus occidentalis californicus*), with up to several thousand roosting pelicans. The pelicans also bathe, feed and roost in nearby Rodeo Lagoon. Western gulls nest on Bird Island; Brandt's cormorants nested there historically and several hundred regularly roost on the island. Breeding cormorants may have been displaced by the recovering brown pelican population. Western gulls and Brandt's cormorants still nest at Lobos Rocks, Land's End and Seal Rocks in San Francisco. Pelagic cormorants nest in very small colonies on precipitous cliffs and sea stacks from the Golden Gate north to Stinson Beach. Black oystercatchers nest on isolated rocky shorelines in the same area. Peregrine falcons are seen foraging along the coastal cliffs and have nested from the Golden Gate Bridge north to Muir Beach.

Sandy beaches, lagoons and estuaries throughout the park, including Tomales Bay, Bolinas Lagoon, Stinson Beach, Muir Beach, Big Lagoon, Rodeo Lagoon, the Golden Gate, Crissy Field and Ocean Beach, provide important habitat for concentrations of migrating and wintering water and shorebirds. Waters within the park are particularly important for loons; grebes; scoters; brant (*Branta bernicla*); numerous species of dabbling ducks, diving ducks, and gulls; Forster's (*Sterna forsteri*), elegant (*Sterna elegans*) and Caspian (*Sterna caspia*) terns; willets (*Catoptrophorus semipalmatus*); sanderlings (*Calidris alba*); western sandpipers (*Calidris mauri*); least sandpipers (*Calidris minutilla*); dunlin (*Calidris alpina*); short-billed dowitchers (*Limnodromus griseus*); and red-necked phalaropes (*Phalaropus lobatus*). Nearshore marine waters provide foraging for hundreds of thousands of sooty shearwaters (*Puffinus griseus*) during spring, summer and fall.

Isolated coastal rocks, beaches, and lagoon sand flats in the park serve as haul-outs for harbor seals and California sea lions (*Zalophus californianus*). Up to 250 harbor seals haul out in Point Bonita Cove at Marin Headlands, and significant harbor seal pupping areas are found in Bolinas Lagoon and Tomales Bay within or directly adjacent to the park. As the northern elephant seal (*Mirounga angustirostris*) population rapidly increases, they are encountered more frequently on sandy beaches throughout the region. California gray whales (*Eschrichtius robustus*), humpback whales (*Megaptera novaeangliae*) and harbor porpoises (*Phocoena phocoena*) use nearshore waters and young whales occasionally wander into San Francisco Bay. Southern sea otters (*Enhydra lutris nereis*) are infrequently seen offshore with numbers increasing as the population spreads north.

Terrestrial habitats within the park support a diversity of mammal and bird species. High densities of meso-carnivores, including the gray fox (*Urocyon cinereoargenteus*), bobcat (*Felis rufus*), and the recently reestablished coyote (*Canis latrans*), inhabit coastal scrub and grasslands in Marin County (Olema Valley, Bolinas Ridge, Tennessee Valley and Marin Headlands), and at Sweeney Ridge and San Francisco Watershed lands in San Mateo County. Mountain lions (*Felis concolor*) have been documented to occur throughout undeveloped areas of these two counties. These carnivores feed on a variety of small and large mammals such as the black-tailed deer (*Odocoileus meionus*), broad-footed mole (*Scapanus larimanius*), pocket gopher (*Thomomys bottae*), deer mouse (*Peromyscus maniculatus*), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), and brush rabbit (*Sylvilagus bachmani*). Badgers (*Taxidea taxus*) are also infrequently encountered. Research by the U.S. Geological Survey (USGS) Biological Resources Division has documented that significantly higher mammalian diversity occurs on ungrazed grassland and coastal scrub than on similar habitat grazed by cattle in the Olema Valley. Some species, such as the western harvest mouse, appear to be restricted to areas where native perennial grasses persist.

Similar differences in diversity between grazed and ungrazed habitats have been documented for landbirds in GGNRA and Point Reyes National Seashore, through research conducted by Point Reyes Bird Observatory. Point Reyes Bird Observatory encountered 83 bird species during 1997 landbird censuses in coastal grassland, coastal scrub, riparian, and mixed hardwood. Species diversity was approximately one-third higher in riparian than in other ungrazed habitats, but was six times higher than in grazed grassland. Species richness was nearly twice as high in riparian habitat than in other ungrazed habitats, but nine times greater than in grazed grassland. Songbird nest monitoring in riparian habitats along Redwood and Lagunitas creeks indicates that nest success for the four most common species: the song sparrow, Swainson's thrush (*Catharus ustulatus*), warbling vireo (*Vireo gilvus*) and Wilson's warbler (*Wilsonia pusilla*), is low and that census counts do not adequately document species status. Three of these species are neotropical migrants and three are designated riparian species of conservation priority by California Partners-in-Flight.

Two coastal grassland/scrub areas in the park are known for their high numbers and diversity of butterflies: Marin Headlands and Milagra Ridge. The federally listed endangered mission blue butterfly (*Icaricia icarioides missionensis*) occurs at both sites, while the San Bruno elfin (*Euphydryas editha bayensis*) is found at Milagra Ridge where it inhabits rocky outcrops. At least 44 species of butterflies occur in the Marin Headlands and 34 species occur at Milagra Ridge, illustrating the importance of habitat fragments within largely developed landscapes. Various species of skippers, swallowtails, hairstreaks, blues, ladies, admirals and crescents inhabit these areas.

In contrast to the extensive coastal grassland/scrub habitats are the coast redwoods of Muir Woods National Monument. Muir Woods is home to the last remaining contiguous stand of old growth coast redwoods (*Sequoia sempervirens*) in Marin County and represents a fragmented island of the redwood forest that existed 150 years ago. GGNRA is currently conducting a wildlife inventory of the old growth forest to better understand its wildlife value. Two pairs of northern spotted owls (*Strix occidentalis*

caurina) occupy Muir Woods, and while potential marbled murrelet (*Brachyramphus marmoratus*) habitat exists, none have been detected in two years of surveys. At least 69 bird species occur within Muir Woods, the most common being the Pacific-slope flycatcher (*Empidonax difficilis*), winter wren (*Troglodytes troglodytes*), golden-crowned kinglet (*Regulus satrapa*) and chestnut-backed chickadee (*Parus rufescens*). Numerous breeding bird species within Muir Woods are neotropical migrants identified as species of management concern.

Thirty species of mammals have been documented in Muir Woods, ranging from the vagrant shrew (*Sorex vagrans*) and Trowbridge's shrew (*Sorex trowbridgii*) to the Sonoma chipmunk (*Tamias sonomae*), western gray squirrel (*Sciurus griseus*), opossum (*Dedelphis virginiana*), and black-tailed deer (*Odocoileus hemionus*). Spotted owls feed primarily on dusky-footed woodrats (*Neotoma fuscipes*). Carnivores include the raccoon (*Procyon lotor*), striped (*Mephitis mephitis*) and spotted skunks (*Spilogale gracilis*), long-tailed weasel (*Mustela frenata*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), bobcat (*Felis rufus*), the recently returned river otter (*Lutra canadensis*), and mountain lion (*Felis concolor*). The most diverse group of mammals found in Muir Woods is bats. Nine species have been identified by mist-netting, acoustic monitoring or spot-lighting in 1999. Three of the species, Pacific western big-eared bat (*Corynorhinus townsendii townsendii*), fringed myotis (*Myotis thysanodes*), and Yuma myotis (*Myotis yumanensis*), are federal and/or state species of concern. Preliminary data from guano traps set in redwood fire-scar cavities in Muir Woods indicate that 60 percent may be used by roosting bats.

Bats have also been studied at the Marin Headlands and on the Presidio. Several historic World War II structures at Marin Headlands were found to be occupied by the Townsend's western big-eared bat, and the Yuma myotis, both federal species of concern. The Brazilian free-tailed bat (*Tadarida brasiliensis*) forages over coastal scrub habitat within Marin Headlands.

While mammalian diversity is low on the Presidio, six species of bats were detected during acoustic surveys conducted as part of wildlife inventories of the Presidio in 1994. By far the most common species was the Mexican free-tailed bat, with hoary bats (*Lasiurus cinereus*) the next most common species encountered. Mountain Lake was found to be the primary bat foraging area, while forest edges between multi-aged forest stands and open areas supported the highest diversity of bats.

Wildlife inventories and a search of collections documented a total of 262 vertebrate species recorded on the Presidio. Approximately 15 of 27 native species of reptiles and amphibians, and 16 of 21 species of native mammals are believed to still occur. For species with poor dispersal capabilities such reptiles, amphibians, and small mammals, the Presidio is an isolated island surrounded by water and urbanization. Common and widespread species, such as the California slender salamander (*Batrachoseps attenuatus*), alligator lizard (*Gerrhonotus coeruleus coeruleus*), California voles (*Microtus californicus*), and western harvest mice (*Reithrodontomys megalotis*) occupy a wide range of habitats and appear to have stable populations on the Presidio. In contrast, these isolated conditions could contribute to future losses of rare species such as the Coast Range newt (*Taricha torosa torosa*), western skink (*Eumeces skiltonianus skiltonianus*), sharp-tailed snake (*Contia tenuis*), Pacific ring-necked snake (*Diadophis punctatus amabilis*), Santa Cruz garter snake (*Thamnophis couchi atratus*), and the gray fox (*Urocyon cinereoargenteus*).

More than 85 percent (225 species) of all vertebrate species that have been observed on the Presidio are birds. The vast majority of these are spring and fall migrants or winter visitors. Approximately 60 species are expected to nest on the Presidio. Lobos Creek and Mountain Lake are especially important habitat areas for a variety of riparian and forest nesting birds. The forests, coastal scrub and grassland, and riparian habitats on the Presidio provide the only large area of open space for migratory birds on the northern San Francisco peninsula.

The Presidio's native habitats and introduced forest are regionally important to nesting olive-sided flycatchers (*Contopus borealis*) and other neotropical migrants (most flycatchers, vireos, warblers, tanagers and grosbeaks), locally declining species such as California quail (*Callipepla californica*), western screech owl (*Otus kennicottii*), wrentit (*Chamaea fasciata*), and Hutton's vireo (*Vireo huttoni*), and at least one species, the hooded oriole (*Icterus cucullatus*), that reaches the northern limit of its breeding range. For these reasons, the Presidio is a link of vital importance to resident and migratory birds in a severely threatened, and poorly understood portion of the Pacific flyway.

2.6 Marine Resources

More than 24 miles of ocean and bay coastline are in the park. Coastal and bay resources comprise biologically diverse and complex ecosystems, which contain a rich array of marine invertebrates and algae (Table 2). Intertidal communities within or adjacent to the boundaries include: islands, islets, reefs, rocks, straits, lagoons, mudflats, beaches, piers, wharves, the Gulf of the Farallones, and the San Francisco Bay-Estuary.

Table 2. Significant Marine Resources in the Golden Gate National Recreation Area

Slide Ranch	Marine life is the most abundant and finest among exposed outer coastlines along the central California shores; a rich display of sponges, bryozoans and tunicates and highly diverse marine invertebrate fauna is matched only by Point Reyes and Tomales Bay in tunicate diversity.
Muir Beach	A wide variety of submarine sponges, hydroids, bryozoans and tunicates.
Pirates Cove	Pristine tidepool life; diversity and abundance are exemplary.
Tennessee Cove	Unique geological features: highly polished living limpet shells of <i>Collisella digitalis</i> very unusual: the only spot in central California that they have been observed. Sea caves contain the isopod <i>Ligia occidentalis</i> of unusually large size.
Kirby Cove	Contains giant isopods, some nearly twice normal length. Such large organisms are not common. High densities of starfish <i>Pisaster ochraceous</i> and <i>Patiria miniata</i> .
Bird Island	Greatest marine resource of the Marin Headlands area, a guano-covered sea stack producing abnormally sized marine invertebrates and plants: containing largest size and greatest densities of chilipepper shrimp (<i>Tigriopus californica</i>) ever observed on Pacific Coast, as well as large California mussels up to seven inches in length, and surfgrass (<i>Phyllospadix</i> sp. — leaves to eight feet in length — marine kelp (<i>Pterygophora californica</i>) and giant kelp (<i>Macrocystis californica</i>) — some stipes seven feet long — green anemone and the purple seastar are of giant proportions. The underwater marine life is exceedingly abundant —all rock surfaces covered with the thickest layer of sponges, hydroids, bryozoans, and tunicates ever observed by Chan in northern California.
Fort Point	Unusually high and significant number (932) of starfish, <i>Pisaster ochraceous</i> , were counted in a 100-meter transect on north seawall.

Source: Chan 1974

GGNRA also contains approximately 50 percent of the rocky intertidal habitat found in the bay (Oceanic Society 1989). Three of the four sites in the San Francisco Bay containing the richest and most pristine assemblage of algae are within the GGNRA: Fort Point, Lime Point and Point Cavallo (Silva 1979). The Alcatraz intertidal zone ranks high in its abundance and diversity of marine algae. The bay flora is far richer than that found in sites outside the Golden Gate, which offer essentially only one habitat (Silva 1979). Within the park management boundaries, 87 marine plant and algae species are present (R-MAP

1996 update for GGNRA). Marine plant and algae along The Presidio and Fort Point total 47 and 66 species, respectively (R-MAP 1996 update for GGNRA).

Intertidal and subtidal areas of the park provide important spawning and rearing habitat for fish. Anchovy spawn in the bay and may play an important role in the population dynamics of anchovy in the California Current (McGowan 1984). From December through April, commercially important Pacific herring (*Clupea pallasii*) spawn in Tomales Bay, the intertidal rocks of Alcatraz, and other central bay rocky shorelines (Inase 1974, USFWS 1989). The reef at Alcatraz also provides a place where many fish feed at high tide (Inase 1979). Due to nearshore and offshore currents, fish cyclically crowd the surf zones of Ocean Beach, Stinson Beach, Bolinas Beach and Dillon Beach (Chan 1974). The intertidal zone supplies fishermen with perch, surf fish, cabezons, blennies, rock fish, abalone, eels, mussels and sea urchins. Typical estuarine fish include brown smoothhound, pile surfperch and white croaker. Lamprey, steelhead trout and coho salmon maintain their annual migrations up Redwood Creek, Olema Creek and Lagunitas Creek. Chinook salmon are commonly caught from park fishing piers within the bay. Green and white sturgeon can still be found in lower Lagunitas Creek, Tomales Bay, and the San Francisco Bay-Estuary.

Commonly visited and accessible intertidal areas in Marin County include Stinson Beach, Slide Ranch, Muir Beach, Tennessee Cove, Rodeo Lagoon and Beach, Bonita Cove, Kirby Cove Beach and Lime Point. The intertidal zone along the coast of Marin County is generally steep and rocky, with small beaches occurring adjacent to watershed drainage areas. Much of the GGNRA intertidal zone in San Francisco County is beach or pier habitat and is also frequently visited. These areas include Fort Funston, Ocean Beach, Land's End, China Beach, Baker Beach, Fort Point, Crissy Field, Fort Mason, Black Point, and Aquatic Park. Many of the intertidal areas serve as living outdoor classrooms for Bay Area residents and visitors. Slide Ranch is frequented by school children, disabled adults and the general public. Areas like Rodeo Beach, Point Bonita, and Fort Baker also provide organized educational experiences.

A multitude of fish species occur offshore of the GGNRA in the Pacific Ocean and the San Francisco Bay. Limited information about fish species and abundance is available from beach seines and trawls conducted by the California Department of Fish and Game for their Delta Outflow/San Francisco Bay study (Fleming 1995). Intertidal and subtidal areas of GGNRA provide spawning habitat for many fish. Anchovy spawn in the bay and may play an important role in the population dynamics of anchovy in the California Current (McGowan 1984). From December through April herring (*Clupea pallasii*) spawn in Tomales Bay, the intertidal rocks of Alcatraz, and other central bay rocky shorelines (Inase 1974, USFWS 1989). The reef at Alcatraz also provides a place where many fish feed at high tide (Inase 1979). Due to nearshore and offshore currents, fish cyclically crowd the surf zones of Ocean Beach, Stinson Beach, Bolinas Beach and Dillon Beach (Chan 1974). The state-protected Dungeness crab (*Cancer magister*) breeds along all sandy beaches. The intertidal zone supplies fishermen with perch, surf fish, cabezons, blennies, rock fish, abalone, eels, mussels and sea urchins.

2.7 Air Resources and Night Sky

Visitors to the park typically enjoy good air quality within the park, despite its proximity to an urban area. Incoming offshore winds generally keep the air in good condition. Sweeping views of the Bay Area and coastline are a trademark of the park. The quality of the air is also vital to the health of the park's ecosystems.

Darkness is a valuable resource for visitors, and critical to the welfare of the park's wildlife. High points in open areas within the park provide excellent opportunities to view the night sky. In particular, such areas that have little or no artificial lighting are sought by visitors to practice amateur astronomy close to home. Wildlife habitat is more valuable when unimpaired by artificial light.

Some areas of the park provide visitors with natural quiet. This is the condition attained when a person with normal hearing can hear nothing but the sounds produced by natural components of the park. It may include “silence” — the apparent absence of any sound; or the rush of air over the wings of a soaring bird; the gentle swish of the wind in the trees; or the overwhelming crash and roar of the ocean on a stormy day. Most often, it is thought of as a mixture of mostly low-decibel background sounds, punctuated by the calls and clatter of wildlife. While much of the park is no longer “naturally quiet,” it may be critical to the wildlife to minimize anthropogenic sound.

3 CONDITIONS AND THREATS TO NATURAL RESOURCES

Many of the natural resources within the GGNRA are deteriorating and are in need of rejuvenation and protection. Past and current land uses have taken a toll on the land, water, air, plants, wildlife, and silence. Current recreational use pressures and practices have added to the continued degeneration of the park resources.

Major current threats to the health of the natural resources include: 1) development adjacent to park boundaries, 2) impacts from visitor uses, 3) non-native species invasion, 4) continuing repercussions of past land use practices, 5) erosion, 6) water diversions, 7) water contamination, 8) lack of fire stimulus to fire-adapted environments, 9) continued park development, and 10) grazing.

The history of the natural areas within GGNRA is intimately tied to the people who worked this land. Soon after the arrival of Europeans, a fire suppression policy began changing the cultural land management practice of annually burning vast areas. Later, agricultural activities began in northern and southern Marin County. The grazing environment of Marin continues to be an important element of the landscape. The 1850s brought the military to San Francisco and San Mateo counties and to southern Marin County, to protect the Golden Gate. The next century saw a wide range of military impacts on the land. Since the establishment of GGNRA, the uses of the land have drastically shifted from the impacts of large organizations to the impacts of individual and group users. The urban pressures for virtually every type of land use are extreme.

3.1 Geologic and Mineral Resources

From an aerial view of the GGNRA landscape, the threats posed to the park from erosion are clear. Coastal waves rhythmically crash against the shoreline; deep, long gullies originate at old roads; heavily used areas are devoid of vegetation; undesignated social trails crisscross through the natural areas; and landslides or slumps exist in most of the small valleys.

Large gully networks range in character from persistently devegetated, rilled slopes to large individual channels up to 15 feet deep and wide. These gullies have been caused by a combination of locally intense rainfall, human disturbance and the presence of highly erodible soils. Many of the gully systems continue to enlarge or are reactivated by uncorrected or renewed land disturbance each year. Other channels have stabilized but remain as persistent scars on the landscape.

Past and current land use practices have altered vegetative composition, aggravated and increased soil erosion, and precipitated landslide activity and recurrent gully formation. These practices have contributed to increasing sediment loads to streams, bays and shorelines. They have also accelerated the loss of large quantities of top soil and have resulted in prominent visual scars and recurrent maintenance costs. Rare species, like the state-listed bank swallow, are affected by erosion from current land uses. At Fort Funston, visitors climb the cliffs and aggravate erosion in the sensitive cliff nesting area. Cultural resources are also threatened in locally active areas such as Alcatraz, where the Warden's House has been undermined by cliff erosion, and Fort Funston, where bluff erosion has claimed coastal batteries.

Some of the worst and most obvious problem areas are in grasslands. Almost without exception, major erosional features have been caused by the diversion of streams or the concentration of seasonal storm runoff by roads and trails.

Past land uses have accelerated erosion in many ways:

1. Many roads developed prior to park establishment were improperly aligned and constructed. These factors have resulted in inadequate drainage, which has led to concentrations of water. These concentrations have created gullies and carried increased sediment yields into creeks, which in turn impairs water quality. In addition, water diversions and the concentration of runoff may initiate or accelerate landsliding in sensitive areas.
2. Grazing has increased erosion by decreasing the amount of vegetation available to capture water, and by compacting the soil, thus deterring infiltration. This then increases runoff, which carries topsoil and sediments into the creeks.
3. Off-road vehicles, hang gliders, bicyclists, horses, dogs, hikers, and other visitors have created denuded areas with compacted soil. Compaction also inhibits infiltration, increasing runoff and erosion. The trend of increasing trail use portends a long term and potentially increasing threat.

The eroding shoreline at the coast of GGNRA threatens beaches and bluffs. The potential exists for the destruction of structures located both within and outside the park. Erosion from wave attack and wind-blown sand occurs on all shorelines. Since human development began, this erosion has increased. Shoreline protection measures, trampling, and drainage changes have all contributed to accelerated erosion. Global warming and associated sea level rise will exacerbate coastal erosion.

Earthquake damage threats depend on the type of underlying material (WRMP 1990). Upland areas on bedrock generally have a low seismic hazard, whereas baylands, unconsolidated sand, and artificial fill areas (such as Crissy Field, Aquatic Park, Fort Mason docks, the mouth of Lobos Creek and along Ocean Beach) may experience intense shaking, subsidence, differential settling and liquefaction. Resultant hazards can include the breaking of water and sewer pipes, streets, sidewalks, concrete structures, etc. Seismic activity can also trigger slope failures.

Serpentine outcrops provide the substrate for a rare habitat that is utilized by many rare plants. These rare sites are found here along the highly developed central California coast. GGNRA serpentine sites are small, and are threatened by a lack of protection. These outcrops are generally unstable and very erodible. Activities such as trampling and grading in or near the outcrops exacerbates the erosion.

Landslides and slumps are potential hazards in the GGNRA. Slopes in the Coast Range are inherently unstable. The strength of the rock has been reduced by intense shearing associated with faulting along the plate margin. Ongoing uplift of the mountains causes continued erosion as the landscape strives to become stable. Surface disturbances, such as cuts for trails and roads, and alteration of surface water drainages, can trigger or lead to slope failures. Most active slumps and landslides in the park are caused by human activities.

3.2 Water Resources

The water resources of the park are constantly under pressure from the urban factors that surround them. This leads to a decrease in water quantity and quality which threatens aquatic and marine species, terrestrial plants, wildlife, and recreational uses.

Historic and current alterations to wetlands and aquatic sites have led to a decrease in functions and species abundance and diversity within the park. Historic fill in wetland and aquatic sites, such as at Fort Baker and Crissy Field, has resulted in long-term loss of habitat. Undersized road crossings and near-channel developments force the clearance of woody materials and vegetation that impair many creeks' ability to support aquatic life.

Decreases in water quantity due to continued water diversions are partially responsible for the decrease in wetland and lagoon habitats, and for the decrease in rare anadromous fish populations. Water rights issues are a concern at Redwood Creek, Lagunitas Creek, Stinson Gulch, Easkoot Creek and McKinnan Gulch. The potential for continued water rights conflicts exists and threatens to continually decrease the amount of water available to the park's natural resources. Areas in the park from which fresh water is diverted include Lagunitas Creek, Olema Creek, Redwood Creek, Tennessee Valley and Lobos Creek. Surface water diversions either upstream or within the park boundaries include: Lagunitas Creek, Olema Creek, Stinson Gulch, Easkoot Creek, Redwood Creek, Tennessee Valley and Lobos Creek. Groundwater is also withdrawn from many of the park's watersheds.

San Francisco Bay-Estuary depends on freshwater inflows from the delta. The bay now receives less than 50 percent of its historical freshwater inflows. The biological communities of the Bay-Estuary are altered by the disruption of natural flow patterns.

Current and past land uses in and adjacent to GGNRA have contributed to fresh water contamination. Agricultural practices, including farming, ranching and stable operations, have caused sedimentation, and organic waste and pesticide problems. Poorly constructed and poorly maintained roads, inherited from prior land owners, concentrate water. This causes gullies, which, in turn, carry sediment into the water resources. Fresh water contamination was identified in a survey conducted by the USGS at eight stations in GGNRA fresh water streams from 1986 to 1988. Bacterial contamination of water and unusually high values of iron, copper, lead, phosphorus, cadmium, and pH were noted at several sites (Medej 1980).

Bay and marine water contamination from toxins, sewage and sediments threaten many park resources. The use of extremely toxic boat chemicals in harbors has led to the contamination of waters around many Bay Area marinas, including the marina adjacent to Fort Mason, and those in Sausalito and Richardson Bay (Citizens for a Better Environment (CBE) 1987). Studies have detected concentrations of silver, cadmium, selenium, DDE and PCBs in Dungeness crab (Tasto 1979). Historic discharge of wastewater effluent at Land's End may have resulted in the impoverished marine flora noted by Silva (1979). However, the Mile Rock outfall structure at Land's End has since been abandoned by the City of San Francisco. Other sewage treatment outfall structures are located adjacent to and within GGNRA in Sausalito and Ocean Beach in San Francisco.

Dog, horse, cattle and human waste may be a significant source of nearshore and lagoon contamination. A substudy of the San Francisco Sewage Master Plan determined that bacterial contamination of waters off Ocean Beach was significant, due to dog fecal matter deposited along the shoreline. The impacts of sewage from the septic systems which serve Muir Beach, Tennessee Valley, Frank's Valley and Slide Ranch have not been studied.

Oil spills occur frequently in the bay and ocean, with some of the most recent affecting GGNRA coastal resources in 1971, 1976, 1980, 1986 and 1989. Seven oil refineries are located in the Bay Area, and oil accounts for 75 percent of the tonnage entering the bay. Past frequencies of oil spills are likely to continue due to the continual pressure to open nearby outer continental shelf leases for oil exploration and development, and due to the existence of refineries here. Oil spills pose a threat to waterfowl, shorebirds and other tidal wetland associated animals (Moffitt and Orr 1937, Houghton et al. 1989).

Resource losses also result from the oil clean up procedure. Mechanical graders used to clean up the oil remove the top six inches of sand along with the oil. This top six inches is where most sand dwelling species occur.

Dredging materials are currently dumped 300 yards off Alcatraz Island, throughout the Golden Gate shipping channel and at the San Francisco Bar. In 1989, DDE-contaminated sludge was dumped near

Alcatraz. Dredging operations can modify or destroy benthic marine resources, which in turn impact intertidal resources. Environmental impacts resulting from a dredging operation potentially include disruption of communities, removal of habitats, a reduction in habitat diversity, destruction of spawning areas, suffocation and burial of organisms, gill abrasion by coarse particles, flocculation of algae, reduction of primary productivity and food finding abilities, increased turbidity and suspended solid levels, alteration of water velocity and current patterns, alteration of the sediment-water interface, increased oxygen consumption and the release of biostimulants and toxic chemicals (Wakeman 1975).

Radioactive wastes dumped in the Gulf of the Farallones National Marine Sanctuary (between 1946 and 1970) are potential environmental hazards (Chan 1977). Approximately 25 percent of the more than 47,500 barrels of radioactive waste have imploded (Dyer 1975). Plutonium and cesium are leaking into the sanctuary and threaten to contaminate the Pacific herring, Dover sole, rockfish, sablefish and Dungeness crab that are commercially fished in the area (San Mateo Times 1990).

Landfills and localized hazardous waste contamination related to past activities have affected the natural resources by changing the soil, vegetation and wildlife habitats. Groundwater is affected and can carry contaminants to freshwater resources and eventually to the bay or ocean. The Presidio of San Francisco has undergone a thorough review of such areas in an attempt to mitigate them in the most effective and efficient manner.

3.3 Plant Resources

Fire was a frequent occurrence in many Mediterranean plant communities, particularly grasslands, chaparral, and scrub. Lightning strikes caused some fires, but during the Holocene, California Indians regularly used fire to manage the landscape for their diverse cultural products. A fire history of the park suggests that in prehistoric times wildland burning occurred at frequencies of 21 to 27 years (McBride and Jacobs 1978). Suppression or complete exclusion of fire during recent decades eliminated the many beneficial effects of fire. These effects on native plant communities are documented in the Fire Management Plan for the park (NPS 1987). Without fire, plant diversity is declining in fire-adapted plant communities such as chaparral and oak woodlands. Douglas fir (*Pseudotsuga menziesii*) and other forest species less tolerant of regular fires are invading these communities, potentially threatening the long-term viability of several rare plant species endemic to chaparral.

Grazing historically occurred on many areas of the park; cattle currently graze on nearly 30 percent of the land within the park. Most of this area is in the park's Northern District and is administered by Point Reyes National Seashore staff, who have prepared Range Management Guidelines to guide management in these areas. Several areas administered by GGNRA are grazed by horses. Due to staffing limitations, management of these areas is sporadic. The lack of a management presence has resulted in adverse impacts to the land.

Grazing is no longer allowed in the Rodeo, Gerbode and Tennessee valleys. The effects of historic grazing practices remain evident and pervasive. These effects include expanding erosion gullies, soil compaction, nutrient enrichment, altered hydrology, increased vegetation cover of non-native pest plant species, and non-native pasture species that have naturalized from plantings and are now expanding into adjacent areas. The natural and recreational resources of these valleys are dramatically affected by the cumulative effect of these changes. In conjunction with other land use changes (i.e., fire suppression), these effects have altered native plant community composition. Native shrub invasion into grasslands is proceeding rapidly, thereby lessening the amount of edge habitat available for wildlife. If shrub encroachment is unchecked by fire, extensive areas of species-rich native coastal prairie will be lost.

The broad variety of recreational uses and high visitation rates combine to create significant effects on natural resources. Hang gliders, off-leash dogs, mountain bikers, horse riders, environmental education groups, and hikers directly and indirectly affect wildlife, vegetation, and soils. The high level of visitor use—more than 20 million annually—creates increasing demands for new development or expansion of existing developments. Such development leads to further fragmentation of wildlife habitat, increased soil disturbance, and non-native pest plant invasion.

The effects of such high visitation rates on natural resources can be partially addressed by improved visitor management: increasing formal and informal education (ranger-led walks and stewardship programs, interpretive signs), increasing enforcement patrols, and closing social trails. But the park's most important tool for slowing and reversing long-term declines in local biodiversity is the stewardship of the land by local communities. The park's extensive restoration efforts are directed towards addressing the impacts of past and current development and recreational use. Its community outreach programs bring in hundreds of park visitors for programs in native plant stewardship and non-native plant species management.

Non-native pest plant species thrive in the park, particularly in areas subject to intensive historic land use (grazing, military occupation) or adjacent to urbanized areas that are a constant source of weed invasion. The spread of non-native plants represents the most significant threat to the biodiversity of the park. One or several of the park's 21 most invasive non-native pest plant species invade approximately 85 percent of the park's estimated 48 plant communities. Research on these invasive plants within the park have been shown to alter community composition and reduce the diversity of native plants (Alvarez and Cushman 1997), insects (Fisher 1997) and small mammals (Howell, pers. comm. 1997). Invasive non-native species are also found within all nine Special Ecological Areas designated as the most biologically intact and diverse areas within the GGNRA (NRMP 1994). Non-native species also directly threaten habitat for the federally endangered mission blue and San Bruno elfin butterflies, Raven's manzanita, Presidio clarkia, and San Francisco lessingia, as well as 12 other special status plants (state and CNPS listed).

GGNRA has currently targeted the 22 most invasive non-native species for control. These species include: Monterey pine (*Pinus radiata*), eucalyptus (*Eucalyptus globulus*), Monterey cypress (*Cupressus macrocarpa*), black acacia (*Acacia melanoxylon*), thoroughwort (*Ageratina adenophora*), cotoneaster (*Cotoneaster* sp.), helichrysum (*Helichrysum petiolare*), Himalayan blackberry (*Rubus discolor*), tall fescue (*Festuca arundinacea*), harding grass (*Phalaris aquatica*), French broom (*Genista monspessulana*), striated broom (*Cytisus striatus*), Scotch broom (*Cytisus scoparius*), Cape ivy (*Delairea odorata*), Ox-eye daisy (*Leucanthemum vulgare*), pampas grass (*Cortaderia jubata*), yellow star thistle (*Centaurea solistalis*), periwinkle (*Vinca major*), gorse (*Ulex europaeus*), capeweed (*Arctotheca calendula*), English ivy (*Hedera helix*), calla lillies (*Zantedeschia aethiopica*). These invasive plant populations are considered under control due to a decade of volunteer, staff and grant expenditures. And despite the extensive urban perimeter around the park, only two new invasive species have established small populations within the park within the last decade.

Nearly 40 percent of the flora in the best studied park unit (the Presidio of San Francisco) is non-native. The extent of invasion is also impressive. At least 10 percent of the 12,000 acres of the Marin Headlands are dominated by non-native species. These non-native plant species affect native biodiversity by displacing rare plant species, altering ecosystem function and process, and changing the natural and cultural aesthetics of the park.

3.4 Rare and Endangered Species

Wildlife

The endangered **California brown pelican** has significant roost areas in GGNRA (NPS 1982). Pelicans have been observed roosting at Seal Rocks, Alcatraz Island, the Hyde Street Pier, Bird Island, and Kent Island in Bolinas Lagoon. Bird Island supports one of the largest concentrations of roosting brown pelicans in northern California with several thousand commonly present in summer and fall. Brown pelicans feed along the outer coast of GGNRA and in Bolinas and Rodeo lagoons. Any threats to roosting or fishing resources can affect them. Human activity, off-leash dogs, and small fishing boats nearshore pose a threat to these roosting areas. Pollution, oil spills, impacts to fisheries, and climatic factors could also cause changes in the quantity and quality of their main source of food, the northern anchovy.

The endangered **American peregrine falcon** (*Falco peregrinus anatum*) has historically nested at three sites in GGNRA (Walton pers. comm. 1991). It has been released from hack sites at Muir Beach from 1983 to 1987 and in 1998. Recolonization first occurred in the Marin Headlands area in the spring of 1990, with a pair resident between the Golden Gate Bridge and Muir Beach throughout the decade. This pair has nested sporadically and mostly without success over the last nine years. Threats to this aerie include visitation by fishermen and adventurers, and toxic contaminants. Between 15 and 30 peregrine falcons of all three subspecies — tundra, Peale's, and the continental — have been observed in the GGNRA by the Golden Gate Raptor Observatory. Peregrines are also known to over-winter on Bolinas Lagoon. Peregrine falcon decline is linked to the organochlorine pesticide DDT, banned in 1972. Pesticide data indicate that DDT is still entering the local environment (Walton and Thelander 1991). The peregrine falcon has been proposed for de-listing by the U.S. Fish and Wildlife Service (USFWS). Peregrine falcons have recovered to approximately 20 percent of their historic breeding numbers in Marin County.

Bald eagles (*Haliaeetus leucocephalus*) have been observed to over-winter in the San Francisco Watershed. An occasional bald eagle is observed during the fall raptor migration by the Golden Gate Raptor Observatory. The bald eagle's drastic decline between 1947 and 1970 was attributed to certain organochlorine pesticides which interfered with their reproduction and caused direct mortalities. According to the USFWS, bald eagle populations appear to be stabilized, or are increasing in numbers. Threats to bald eagles in GGNRA could include the introduction of certain pesticides into the environment or food chain, and disruption of roosting or prey resources.

The **northern spotted owl** was listed as a threatened species by the USFWS on June 22, 1990 (USFWS 1990). Northern spotted owls are widely distributed in forested regions from southern British Columbia through Washington, Oregon, and northwestern California. They reach the southern limit of their range in Marin County, where they occur in Golden Gate National Recreation Area, Muir Woods National Monument, Point Reyes National Seashore, and other parts of the county. These three national park units began a joint systematic survey for spotted owls in Marin County in 1993. Preliminary results of these surveys indicate that the county may support the highest density of spotted owls nationwide (R. Gutiérrez pers. comm.). A total of 83 known owl sites have been identified in the study area, including at least 52 pairs located in 1998.

Northern spotted owls are typically found in old- and mature second-growth forests, but in Marin County they reside in second- and old-growth Douglas fir, bishop pine, coast redwood, mixed conifer-hardwood, and evergreen hardwood forests. Preliminary pellet analyses indicate that spotted owls in Marin County forage primarily on dusky-footed woodrats as well other small mammals and forest-dwelling birds.

This isolated Marin County spotted owl population is subject to unique threats present in the region including: 1) urban development along protected-area boundaries, 2) intense urban recreational pressures, 3) increased controlled burns and wild fires along the urban/wildland interface, 4) potential for catastrophic wildfires due to unnatural fuel buildup and spread of invasive species (Monterey pine, eucalyptus), 5) possible genetic isolation, and 6) range expansion of the barred owl (*Strix varia*).

The **marbled murrelet**, a federally threatened species, is extremely sensitive to disturbance, including noise and human activity, in the vicinity of nesting areas, which are found in forest stands with old growth characteristics. A few unverified inland sightings have been reported since 1990. Systematic surveys have been conducted in Muir Woods National Monument from 1997 to 1999; no murrelets have been detected within the old growth redwood forest. Marbled murrelets are infrequently seen in nearshore waters from mid-summer through winter. GGNRA is also assisting the CDFG to identify other suitable areas to survey in Marin County. Detection of breeding murrelets in Marin would be extremely significant as there is a geographical gap between breeding populations in San Mateo and Santa Cruz counties to the south, and Mendocino County to the north.

The **bank swallow** (*Riparia riparia*) colony at Fort Funston is the largest nesting colony of bank swallows in the San Francisco Bay Area. More than 700 burrows (approximately 40 to 50 percent of which are occupied) were present in 1997, although European starlings invaded the colony in the mid-1990s and displaced bank swallows from some areas of the colony. American kestrels preyed on significant numbers of both adults and young during this period as well. Kestrel populations may be unnaturally elevated due to the abundance of cavities available in urban homes and buildings. The Fort Funston bank swallow colony suffered a significant set back as a result of severe storms and coastal erosion caused by El Niño conditions during the winter of 1998. Coastal erosion was also accelerated in this area during 1999. The colony was reduced to approximately 150 burrows (40 to 50 percent occupied) in 1998, but with very few starlings present. The colony shifted south from areas used earlier in the 1990s, with the potential for increased conflict with hang-gliders flying at Fort Funston.

Bank swallows migrate from South America to nest in the beach cliffs of Fort Funston and as both perching birds and migratory birds are protected by the Federal Migratory Bird Treaty Act. The nesting range of the bank swallow in California has declined by approximately 50 percent since 1900.

The Golden Gate Audubon Society has expressed concerns regarding threats to the Fort Funston bank swallow colony. Rock climbers have been observed rappelling through the active colony. People also frequently climb the cliffs in the vicinity of the colony and it is a favorite site for graffiti and name-carving in the sandstone. The sandstone bluff is extremely erodible. During Fourth of July festivities fireworks have sometimes been aimed at the colony site from the beach below (Murphy 1989). The beach is now closed in the bank swallow area on the Fourth of July with active enforcement of the closure. The site is also adjacent to the park's only approved hang-gliding area, but flight is prohibited near the colony during breeding season.

The **western snowy plover** (*Charadrius alexandrinus nivosus*), federally listed as threatened in 1993, winters on Ocean Beach in San Francisco from mid-July through early May. It is severely impacted by intense human use and off-leash dogs. An average of between 25 and 85 plovers have used the beach each winter since 1994, with higher numbers in years when beach width is widest, and lower numbers in years when severe winter storms and El Niño conditions result in a much narrower beach profile. A draft snowy plover management plan was prepared in 1997 and revised in 1998. The park established a snowy plover management area from Sloat Boulevard in the south to Stairwell 21 in the north along the O'Shaughnessy seawall, based on several years of monitoring data. Beginning in 1997 the park began enforcing NPS leash regulations within the snowy plover management area, terminated all sand movement activities, and limited park vehicle operation within the plover area during the time that

plovers are present. Seven drownings occurred on Ocean Beach during 1998, necessitating changes in vehicle use patterns on the beach. The management plan will be revised again in 1999 and finalized to address changes in vehicle use practices.

The endangered **mission blue butterfly** inhabits Milagra Ridge in Pacifica, Sweeney Ridge in San Bruno, and portions of the Marin Headlands. The populations are threatened by loss of habitat due to development and trampling by excessive foot traffic, illegal off-road vehicles, non-native plant invasion, and some routine maintenance activities have resulted in habitat degradation and loss of butterflies within the park. Several butterfly habitat restoration projects are currently underway in the park involving non-native plant removal and native plant restoration.

The endangered **San Bruno elfin butterfly** (*Incisalia mossi bayensis*) occurs in GGNRA at Milagra Ridge in Pacifica. It is threatened by displacement of host and of nectar sources by non-native plant invasion, trampling by people, lack of proper fire management, and development.

The **Bay checkerspot butterfly** (*Euphydryas editha bayensis*) inhabits Edgewood Park in the San Francisco Watershed. It is threatened by development and non-native plant invasion.

The endangered **California least tern** (*Sterna antillarum browni*) does not nest in the park, but uses abandoned piers for roosting and nearshore waters for foraging. Recent proposals to increase ferry traffic within San Francisco Bay and to new locations in the park may affect roosting and foraging patterns.

The **southern sea otter**, a federally threatened species, occurs infrequently in GGNRA marine waters but sightings are increasing and a population of approximately 50 males now inhabits Fitzgerald Marine Reserve in northern San Mateo County. As the population rapidly expands northward, increased sightings and beached animals are expected. The southern sea otter population has been declining by 11 percent per year over the past three years due to unknown causes. It is believed that marine pollution, disease and commercial fisheries operations may be responsible for this alarming decline. The USFWS is currently considering changing the southern sea otter's status to endangered.

The federally threatened **Steller sea lion** (*Eumetopias jubatus*) was historically a frequent sight on Seal Rocks in San Francisco. The population in California has declined dramatically and they are now extremely rare even on the Farallones. One individual was recently observed at Pier 39 in San Francisco.

Humpback whales, federally endangered, are infrequently observed nearshore and occasionally wander into San Francisco Bay. Whale species have primarily been impacted by whaling activities in the past and by foreign countries that do not abide by international protections afforded most whale species.

The **salt marsh harvest mouse** (*Reithrodontomys raviventris*), a federally endangered species, has been found during small mammal inventories at Rodeo Lagoon. This species is threatened by loss of habitat to development and filling of wetlands around San Francisco Bay.

The **San Francisco garter snake** has been listed as endangered by the USFWS and CDFG since 1967. This snake is endemic to San Mateo County, where it occurs in the San Francisco Watershed and a few other sites (USFWS 1985). Milagra Ridge is potential habitat for the San Francisco garter snake because of the presence of prey items and the historic occurrence of the garter snake in sag ponds along Skyline Road (Barry, pers. comm. 1999).

The current condition of the snake in the San Francisco Watershed is unknown and has resulted in threats from routine maintenance. If the snakes inhabit Milagra Ridge, they may be threatened by dogs, collectors, and the development of upland habitat on ridges north and east of Milagra Ridge.

The **California freshwater shrimp** is endemic to Marin, Sonoma and Napa counties, but only remains in portions of 16 coastal streams. Lagunitas Creek in Marin County contains the most viable population of the shrimp and it is the only site occurring on protected lands. The shrimp is threatened by water diversions on Lagunitas Creek, watershed erosion, stream sedimentation, riparian vegetation removal, agricultural development, grazing, and urbanization.

The threatened **California red-legged frog** is found at several park locations within the San Francisco peninsula and in Marin County. It has been extirpated from 70 percent of its former range. Threats to this species include urban encroachment, construction of reservoirs and water diversions, introduction of non-native predators and competitors, livestock grazing, and habitat fragmentation.

The endangered **tidewater goby** currently lives in Rodeo Lagoon. It is the only remaining location with tidewater gobies within the greater Bay Area counties. Historic records indicate that the goby occurred in at least 9 other locations within the San Francisco Bay Region, such as Lake Merced and Corte Madera Creek (Swift et al. 1989). Threats to this species include loss of habitat through excessive sedimentation, poor water quality, and non-native competitors.

The threatened **steelhead trout** (Central California Coast Evolutionarily Significant Unit [ESU]) is found in many perennial coastal streams within the park. In addition, the offshore waters along the Pacific coast as well as estuarine areas in San Francisco Bay and Tomales Bay provide rearing habitat for steelhead. Human threats to this species include degradation of spawning gravels, habitat simplification, and water diversions.

The threatened **coho salmon** (Central California Coast ESU) is found in Lagunitas, Olema, and Redwood Creek watersheds. Juveniles are often found in deep pools with abundant cover in the form of undercut banks, overhanging vegetation, and woody materials. In addition, the offshore waters along the Pacific coast as well as estuarine areas in Tomales Bay could provide rearing habitat for coho salmon. Human threats to this species include degradation of spawning gravels, habitat simplification, and water diversions.

Plants

Sensitive plant species are subject to a variety of threats. Table 3 identifies the threats to each and the management actions that are currently being undertaken.

Table 3. Sensitive Plant Threats and Recovery Actions

Common Name	Scientific Name	Federal Listing	State Listing	CNP S	Annual Monitoring	Threats	Management Action Underway
San Mateo thornmint	<i>Acanthomintha duttonii</i>	FE	SE	1B	yes	Maintenance activities	None
Coast rock cress	<i>Arabis blepharophylla</i>		CSC	4	yes	Non-native species	Protection, non-native species removal
Tamalpais manzanita	<i>Arctostaphylos hookeri</i> ssp. <i>montana</i>			1B	yes	Fire suppression and non-native species	None
Presidio or Raven's manzanita	<i>Arctostaphylos hookeri</i> ssp. <i>ravenii</i>	FE	SE	1B	yes	Non-native species, significant loss of habitat, one remaining parent plant	Protection, research, non-native species removal
Montara manzanita	<i>Arctostaphylos montaraensis</i>		CSC	1B	yes	Fire suppression	None
Marin manzanita	<i>Arctostaphylos virgata</i>		CSC	1B	yes	Douglas fir encroachment/fire suppression	Non-native species Removal
Oakland star-tulip	<i>Calochortus umbellatus</i>			4	yes	Grazing, non-native species	None
Tiburon Indian paintbrush	<i>Castilleja affinis</i> ssp. <i>neglecta</i>	FT	SE	1B	yes	Grazing, non-native species	None
Indian paintbrush	<i>Castilleja subinclusa</i> ssp. <i>franciscana</i>			4	yes	Grazing, non-native species	None
Point Reyes ceanothus	<i>Ceanothus gloriosus gloriosus</i>			4	yes	Douglas fir encroachment/fire suppression	None
Glory brush	<i>Ceanothus gloriosus</i> var. <i>exaltatus</i>			4	yes	Douglas fir encroachment/fire suppression	None
Bolinas or Mason's ceanothus	<i>Ceanothus masonii</i>	FT	CSC	1B	yes	Douglas fir encroachment/fire suppression	Protection, non-native species removal
San Francisco spineflower	<i>Chorizanthe cuspidata</i> ssp. <i>cuspidata</i>		CSC	1B	yes	Non-native species, reduced natural dune process	Protection, non-native species removal, habitat creation
Franciscan thistle	<i>Cirsium andrewsii</i>			4	yes	Non-native species	Protection, non-native species removal, research, habitat creation

Common Name	Scientific Name	Federal Listing	State Listing	CNP S	Annual Monitoring	Threats	Management Action Underway
Fountain thistle	<i>Cirsium fontinale fontinale</i>	FE	SE	1B	yes	Maintenance activities, non-native species	None
Presidio clarkia	<i>Clarkia franciscana</i>	FE	SE	1B	yes	Non-native species, significant reduction in habitat	Protection
Point Reyes salt marsh bird's beak	<i>Cordylanthus maritimus</i> ssp. <i>palustris</i>		CSC	1B	no	Unknown	None
Western leatherwood	<i>Dirca occidentalis</i>			1B	yes	Maintenance activities	None
California bottle-brush grass	<i>Elymus californicus</i>		CSC	4	yes	Non-native species	Non-native species removal
Tiburon buckwheat	<i>Eriogonum luteolum</i> var. <i>caninum</i>		CSC	3	yes	Non-native species	None
San Mateo wooly sunflower	<i>Eriophyllum latilobum</i>	FE	SE	1B	yes	Non-native species, maintenance activities	None
San Francisco wallflower	<i>Erysimum franciscanum</i>		CSC	4	yes	Non-native species	Protection, non-native species removal
Fragrant fritillary	<i>Fritillaria liliacea</i>		CSC	1B	yes	Grazing, non-native species	None
Dune gilia	<i>Gilia capitata</i> ssp. <i>chamissonis</i>			4	yes	Non-native species, reduced natural dune process	Protection, non-native species removal, habitat creation
San Francisco gumplant	<i>Grindelia hirsutula</i> var. <i>maritima</i>		CSC	1B	yes	Non-native species	Protection, non-native species removal
Marin dwarf flax	<i>Hesperolinon congestum</i>	FT	ST	1B	yes	Non-native species, significantly reduced habitat	Protection, non-native species removal
Wedge-leaved or Kellogg's horkelia	<i>Horkelia cuneata</i> var. <i>sericea</i>		CSC	1B	no	Unknown	None
Crystal Springs lessingia	<i>Lessingia arachnoidea</i>			1B	yes	Non-native species, maintenance activities	None
San Francisco lessingia	<i>Lessingia germanorum</i>	FE	SE	1B	yes	Non-native species, reduced natural dune process	Protection, research, non-native species removal, habitat creation
San Mateo tree lupine	<i>Lupinus eximius</i>		CSC	3	yes	Non-native species, maintenance activities	None

Common Name	Scientific Name	Federal Listing	State Listing	CNP S	Annual Monitoring	Threats	Management Action Underway
Santa Cruz Island bush mallow	<i>Malacothamnus fasciculatus</i> var. <i>nesioticus</i>	FE	SE	1B	yes	Non-native species, maintenance activities	None
White-rayed pentachaeta	<i>Pentachaeta bellidiflora</i>	FE	SE	1B	yes	Non-native species, maintenance activities	None
Choris' popcornflower	<i>Plagiobothrys chorisianus</i> var. <i>chorisianus</i>			3	no	Unknown	None
Dolores or San Francisco campion	<i>Silene verecunda</i> ssp. <i>verecunda</i>		CSC	1B	yes	Non-native species, reduced natural dune process	Protection, non-native species removal, habitat creation
Santa Cruz microseris	<i>Stebbinsoseris decipiens</i>		CSC	1B	no	Unknown	None
Tamalpais jewelflower	<i>Streptanthus glandulosus</i> var. <i>pulchellus</i>		CSC	1B	yes	Non-native species	None
San Francisco owl's clover	<i>Triphysaria floribunda</i>		CSC	1B	yes	Non-native species, significantly reduced habitat	Protection, non-native species removal

KEY TO TABLE 1

FEDERAL LISTING STATUS

FE = Federally Endangered

FT = Federally Threatened

STATE LISTING STATUS

SE = State Endangered

ST = State Threatened

CSC = California Species of Special Concern (California Department of Fish and Game 1998)

CNPS: California Native Plant Society status

1A = Presumed extinct in California

1B = Rare or endangered in California and elsewhere

2 = Rare or endangered in California, more common elsewhere

3 = Needs more information

4 = Plants have limited distribution

Watch List: CA/National and California - National Audubon Society

PIF: Partners-in-Flight

SCP: Species of Conservation Priority

CDF: California Department of Forestry

3.5 Wildlife Resources

While the park supports an extremely diverse array of wildlife species and their habitats, a broad range of forces threaten the viability of these wildlife populations and the habitats they depend upon. No corner of the park is untouched by human influence.

Park-Wide Resources

Threats to wildlife and their habitats throughout the park fall into a number of broad categories such as habitat fragmentation, non-native animals, human disturbance, domestic and feral animals, non-native plant invasion, environmental contaminants, wildland fire, hazard fuel reduction, etc. Brief discussions of these threats follow.

Habitat fragmentation, degradation and isolation are inherent features of parklands situated along the urban interface. As fragmentation and isolation of wildlife habitat increase with further development on lands surrounding the park, the park's importance as a refuge, and for providing corridors for wildlife populations, increases. Maintenance of biodiversity and viable wildlife populations are dependent on the park's ability to maintain and restore habitat corridors at the landscape level, within and beyond park boundaries.

Non-native animals identified as problem species within native wildlife habitat in the park include brown-headed cowbirds (*Molothrus ater*), wild turkeys (*Meleagris gallopavo*), European starlings (*Sturnus vulgaris*), peacocks (*Pavo cristatus*), fallow deer (*Cervus dama*), feral hogs (*Sus scrofa*), and Norway and black rats (*Rattus norvegicus* and *R. rattus*).

Brown-headed cowbirds parasitize open-cup nests of birds. Neotropical migrants and riparian nesting birds are particularly susceptible. Cowbird parasitism is widespread throughout the park, but the level of parasitism and the lack of concentrated foraging areas make cowbird control unrealistic. Neotropical migrants are threatened by elevated predation levels (probably resulting from habitat modification), loss of habitat and parasitism. Wild turkeys were recently introduced into Marin County by the CDFG. Wild turkeys feed on a wide variety of foods including native frogs and native plants and seeds. Peacocks have similar habitat impacts. European starlings are cavity nesters that compete with and displace native species from limited nesting habitat. American kestrels (*Falco sparverius*), bank swallows (*Riparia riparia*) and other cavity nesters are impacted by the widespread occurrence of starlings.

The fallow deer population in Point Reyes and on GGNRA northern lands in the Olema Valley and on Bolinas Ridge continues to expand. No current population estimates exist and only very limited efforts to reduce the herd size have occurred over the last 5 years. Small to large herds are now regularly seen on ranch lands along Bolinas Ridge. Fallow deer may compete with native black-tailed deer for forage, transmit diseases, and modify native plant communities.

Feral hogs were widespread in the park during the 1980s but appear to have been successfully eradicated through hunting and trapping efforts by the NPS. Only a few unconfirmed sightings have been reported over the past 5 years. Feral hogs have potential to seriously degrade habitat and native animals populations through soil disturbance, uprooting of native plants, competition for foraging resources, particularly acorns, predation on small animals, and disease transmission. Feral hog populations could rapidly increase again at any time in Marin or San Mateo counties.

Norway and black rats are known to occur in various locations throughout the park, including Muir Woods, Alcatraz, Olema Valley and Marin Headlands. Rats prey on native wildlife and their young. They were found preying on the Townsend's big-eared bat in Olema Valley, where steps were taken to

discourage and exclude them from the maternity roost. They are also a threat to burrow-nesting birds (such as pigeon guillemots on Alcatraz) that leave their young unattended while the adults forage at sea. Black rats are excellent climbers and will take eggs and young out of nests in tall shrubs and trees. Rats also carry diseases and constitute a human health threat wherever they occur.

Isolated populations of red foxes (*Vulpes vulpes*) are known to occur in Marin and San Mateo counties but have not been confirmed in the park. They pose a serious threat to the viability of small mammal and ground-nesting bird populations where they occur.

Unnaturally elevated populations of native animals, including ravens and other corvids, raccoons and skunks, occur along the urban-wildlife interface where supplemental food sources are abundant. Raccoons and skunks may transmit diseases to people and pets, and exhibit nuisance behavior. Supplemental food sources and elevated small mammal populations (including domestic dogs and cats) may attract larger predators like mountain lions and coyotes to more populated areas with potential for unwanted conflicts.

Domestic and feral animals (cats and dogs) may transmit diseases to visitors as well as wildlife populations, prey on birds and other small mammals and invertebrates, dogs may hybridize with coyotes or experience aggressive territorial encounters with them. Domestic animals (leashed or unleashed) on trails and other parklands may displace wildlife from their native habitats, or harass, disturb or depredate a wide range of wildlife species, including shorebirds, black-tailed deer, and marine mammals.

Livestock grazing by cattle is permitted within the Olema Valley and along Bolinas Ridge. Limited grazing by horses occurs in the vicinity of horse stables within the park. Cattle grazing results in riparian habitat degradation, decline in numbers and diversity of small mammals and landbirds in all grazed habitats, and degradation of native grasslands. In one area of the park, native grasslands support large numbers of western harvest mice while adjacent non-native grasslands do not.

Park visitors and human disturbance impact park wildlife through a wide range of activities. Marine mammals are disturbed by tidepool study, boaters, clam diggers and aircraft overflights and off-leash dogs. They are also shot by commercial fishermen. Shorebirds, waterbirds and seabirds are disturbed by similar activities. Illegal bike trails and social trails destroy wildlife habitat and result in increased disturbance to wildlife in undeveloped areas of the park. Gang activity (nighttime graffiti in historic structures) may disrupt night roosts of sensitive bat species.

Poaching likely occurs in more remote areas of the park, resulting in disturbance and loss of wildlife.

Pathogens of unknown origin, likely both introduced and native, affect marine mammals, birds, terrestrial wildlife, and wildlife habitat. Humans may represent a significant dispersal agent for many pathogens. Sudden death of tanoak disease threatens to kill tanoak trees throughout the park. This disease has been documented in Muir Woods and other areas of Marin County, as well as in Santa Cruz County to the south of the park. Acorns, largely from tanoaks, are a major food source for many terrestrial wildlife species including deer and woodrats which are important food sources for species higher on the food chain. A significant tanoak die-off would have serious repercussions for wildlife diversity and abundance on a landscape level within and around the park.

Non-native plant invasion by a wide variety of introduced species (Cape ivy, French broom, Scotch broom, eupatorium, pampas grass, non-native grasses, thistles, etc.) results in loss of hundreds of acres of riparian, terrestrial and aquatic habitats that are critical to wildlife abundance and diversity throughout the park. The park's vegetation management program expends hundreds of thousands of dollars and volunteer hours on eradication of non-native plants and restoration of native habitats.

Continued park development and park operations impact wildlife as well as plant, water and soil resources. Facilities and trail maintenance and development frequently conflict with protection of sensitive wildlife species and habitat protection in areas like the Presidio, Fort Baker, Marin Headlands, Alcatraz, Muir Woods, Sweeney Ridge, and the Phlegar Estate. Park operations, programs and routine activities including road and trail maintenance, trail bridge construction, firearms qualifications, and concession operations potentially threaten sensitive wildlife resources, particularly during mating and nesting season.

Wildland fire and hazard fuel reduction programs also impact native wildlife and their habitats. Catastrophic wildfires may occur as a result of more than a century of fire suppression and fuel buildup. Vast areas of wildlife habitat may be impacted, directly and indirectly, as a result of events like the 1995 Vision Fire at Point Reyes. Non-native plant invasions have been especially aggressive following wildfires in this region. Heavy equipment used for fire suppression may compact soils and alter drainage patterns and wildlife habitat. Large numbers of native wildlife are killed or displaced as a result of catastrophic wildfires. Hazard fuel reduction programs, including prescribed burning and habitat modification, are designed to prevent such catastrophic losses of park resources. They, in turn, result in habitat modification and direct and indirect effects to wildlife and their habitat. Careful interdisciplinary planning and proper timing of activities are critical to protecting existing habitat values.

Coastal erosion and shoreline stabilization result in natural and human-induced impacts to wildlife habitats in the park. Coastal erosion, which is affecting bank swallow, shorebird, and harbor seal habitat availability, may be accelerated due to global warming. Shoreline stabilization projects to protect property adjacent to the park may alter coastal processes and sand transport along Ocean Beach, that in turn affect habitat for migratory and wintering shorebirds and snowy plovers. Shoreline stabilization projects, sand maintenance, and repair of outfalls along Ocean Beach require use of heavy equipment on the beach that may disrupt normal activity patterns of roosting and foraging shorebirds, terns and gulls.

Environmental contaminants, such as DDE, polychlorinated biphenyls (PCBs), heavy metals, residual DDT, petroleum products, asbestos and lead-based paint, affect the health and reproductive success of numerous park wildlife species such as harbor seals, peregrine falcons, black-crowned night-herons, snowy plovers, and seabirds. Many historic structures in the park, often in areas inhabited by native wildlife, are contaminated with lead-based paint, asbestos, and petroleum products in abandoned fuel lines. Oil spills have affected the entire shoreline of the park, both within San Francisco Bay and along the outer coast. Numerous species of wildlife, particularly water birds, shorebirds and harbor seals, have been oiled and injured or killed in these events. Poor water quality may affect aquatic and terrestrial animals that live or forage in contaminated waters.

Light pollution from excessive or unshielded night-lighting within the park, and cumulative urban light sources, affect the nighttime habitat and habits of park wildlife. Darkness provides refuge and protection for wildlife resting or hunting at night. Wildlife may be more vulnerable to predation and behavior patterns may be altered where light pollution affects their habitat.

Island Resources

Alcatraz is a 21-acre island in the middle of San Francisco Bay that receives 1.4 million visitors a year. Alcatraz represents the extreme of potential, impending, existing and cumulative internal and external threats and pressures on park wildlife resources. The island's historic structures are in urgent need of structural stabilization to address human health and safety issues. Stabilization of historic structures on the island is a challenging task that will take years or decades to complete. Many construction activities are constrained by the prolonged colonial bird-nesting season on the island that lasts from February to

September. An Environmental Impact Statement is in preparation to address threats to the island's wildlife resources from the range of construction activities expected over the next 5 to 10 years.

Other internal threats and pressures on Alcatraz wildlife include increased visitation, expanded hours of operation, night lighting, special events, expanded access to more areas of the island, accessible tram routing, access to closed areas during breeding season for construction projects, helicopter use for park operations, film production including pyrotechnic displays, Norway rat predation, common raven predation, food service for special events, and toxic contaminants within the island landscape. Some of these threats are being addressed through ongoing Norway rat control efforts, cleanup of contaminants, increased wildlife monitoring, and implementation of additional wildlife protection measures. Existing disturbance monitoring data are inadequate to predict the consequences to wildlife of many proposed activities.

The GGNRA has documented a wide range of external threats to Alcatraz wildlife resources. Most of these involve disturbance to wildlife from activities too close to breeding bird colonies. Documented disturbance sources include: aircraft overflights (civilian and military helicopters, air tours), commercial and sport fishing boats, dredge spoil barges, recreational boaters (kayakers, personal watercraft, sailboats, motorized boats), illegal boat landings, and un-permitted events offshore (laser light shows, fireworks displays, firing of cannons). Other existing or potential external threats include: disposal of dredge spoils within the park boundary, toxic contaminants in San Francisco Bay foraging resources, oil spills, and proposed removal of submerged rocks (that may support valuable foraging resources), to improve harbor safety. The park has initiated outreach efforts and protection measures and is developing strategies for addressing disturbance from external sources.

3.6 Marine Resources

Non-native marine invertebrates are present within park boundaries. The San Francisco Bay-Estuary has 212 species known to have been introduced and the dubious distinction of having the most non-native aquatic species in North America (Cohen and Carlton 1995). The introduced species present in the park include (but are not limited to) Asian clam (*Corbicula fluminea*), yellowfin goby (*Acanthogobius flavimanus*), and Sargasso weed (*Sargassum muticum*). The yellowfin goby has been identified as a potential threat to the listed tidewater goby. Many kilometers of bay shoreline have been eroded due to the activity of a boring and burrowing isopod, *Sphaeroma auovanum*. The isopod weakens clay banks, dikes and levees, facilitating their removal by wave action. The greatest impact results from non-native species competition with native species (Carlson 1979).

Adverse visitor impacts on various intertidal areas is a threat. The accessibility of rocky intertidal areas to an urban center invites visitor usage can result in visitor-related impacts to the habitat. Changes in many of the park's intertidal areas have taken place and will continue to do so, because of the lack of basic marine resources information and lack of protection. Visitors to the intertidal zone can impact the habitat in many ways:

1. Damage to the adhesive organs of starfish and snails occurs when people remove them from surfaces.
2. Damage to sedentary animals (such as barnacles and mussels) and to plants that occurs when they are removed often destroys the entire organism.
3. Damage to organisms that rely on rocks for habitat and protection results from turning over rocks and not replacing them in their original position.

4. Removal of empty shells as souvenirs eliminates potential homes for other organisms, the most conspicuous of these being the hermit crab.
5. Damage occurs from trampling by large groups throughout intertidal areas, particularly at low tide.
6. Overzealous collecting and handling may eliminate uncommon species.
7. Litter poses a threat to unique resources in intertidal areas. The stepladder tidepools of Bird island have been contaminated with fishermen's debris, cardboard, cigarettes, beer cans, newspapers and plastic lids (Chan 1974). Dr. Johnson Wang has recommended that littering be more actively discouraged at Rodeo Beach due to the tidewater goby, a federal candidate for listing, that resides in Rodeo Lagoon near the sand bar.

Sport and commercial fishing can affect the reproductive success of herring, bass and anchovies in the bay and in the Gulf of the Farallones, which in turn would affect the many birds and mammals dependent on these resources. A total of 18.7 million pounds of fish was harvested by commercial operations in 1984 (BCDC 1986). An active commercial fishery for herring occurs in waters owned and leased by the park along the San Francisco and Marin peninsula shorelines.

Intertidal fishing and collection have an adverse impact on the ecology of these habitats. Public access for pier fishing is available at Fort Point, Fort Mason, Alcatraz, Lime Point, and Fort Baker. CDFG regulations allow the removal of specified quantities of mussels, sea urchins, abalone, eel, rock crabs, herring eggs and surf fish from the intertidal zone.

Herring lay their eggs on seaweed, which can be legally collected. Observations of mussels and abalone in frequently visited sites are not abundant, and the pressure of hunters has probably contributed to the disappearance of the razor clams from Stinson Beach. Repeated dives in 1974 documented that there were no abalone at Muir Beach or Bird Island, and only sparse numbers at Pirates' Cove and Slide Ranch. "Game" species are an integral component of the shoreline ecology. Over-fishing of game species such as clams, abalone, urchins and mussels may lead to their decline in shoreline waters (Chan 1974).

Game regulation enforcement is not adequate. Park rangers, park police, and natural resources personnel have observed poaching at several locations and have expressed concern regarding inadequate game regulation enforcement. Although it is illegal to take Dungeness crabs from San Francisco Bay, intentional and uninformed poaching of crabs from piers is an ongoing problem (CDFG 1999).

Dungeness crab are especially vulnerable to illegal fishing because they migrate along the bottom near piers. Much illegal crabbing occurs at night and the lack of lights and enforcement at the piers hinder nighttime enforcement (CDFG 1999). Dungeness crabs are also taken by people who cannot distinguish them from other market crabs.

Global warming will have an impact on marine and terrestrial habitats. The temperature will rise, but precipitation will remain the same, creating drier conditions for plants. More stress on plants may lead to a reduction in associated animal populations (The Bay Watcher 1989).

Rise in sea level over the next century will result from global warming (The Bay Watcher 1989). Rising sea levels mean rising bay levels and resultant changes in GGNRA's natural resources. Everything from phytoplankton to marine mammals could be affected. Some of the potential impacts that can be foreseen include: a reduction in primary productivity due to saltwater intrusion in the productive shallows of San Pablo and Suisun bays and the flooding of marshes and impacts on Pacific flyway and local waterfowl. The result could be a general decline in most bay species of fish, shellfish, marine mammals and birds.

3.7 Air Resources and Night Sky

Air resources and night sky are affected by changes in **air quality**. Aerometric and meteorological data are collected by the Bay Area Air Quality Management District (BAAQMD). They have 29 sites in the greater Bay Area, two of which are in San Francisco, and one of which is in San Rafael. In addition, the BAAQMD monitors air quality in a tower network of 28 different Bay Area sites. One of these sites is at Fort Funston and a second is on Mt. Tamalpais. As a result, GGNRA has access to air quality data within and near the park. According to the BAAQMD, the condition of the air in the park is “good” and no known acid deposition is occurring due to the local climatic factors. The BAAQMD meets all federal air quality standards except 1-hour ozone, and annual and 24-hour particulate matter 10 microns in diameter (PM₁₀).

Poor air quality days in the Bay Area can create severely impaired visibility. The sweeping views of the smog blanket detract from the visitor’s experience. Some individuals may need to avoid outdoor activity or take special health precautions. In addition, negative impacts to the park’s ecosystems may occur due to periods of poor air quality. The park does not actively participate in the BAAQMD’s “Spare the Air” program, which is designed to reduce air quality impairment during the smog season.

While high open areas in the park may provide opportunities to view the night sky, most of these locations are subject to light pollution from the surrounding Bay Area. Lighting within and adjacent to the park also reduce the darkness of the night sky. Data have not been collected to evaluate the darkness of the sky within GGNRA, nor has a plan been developed to protect or improve night sky viewing.

Wildlife habitat is impaired by **artificial lighting**. Park lighting, lights from adjacent property, and the overall sky glow from the Bay Area contribute to the nighttime degradation of habitat. The park does not have a plan to address preservation and restoration of dark habitat.

The park’s **urban setting** threatens protection and restoration of natural quiet. Aircraft, watercraft and road traffic outside the park all contribute to noise levels within the park. Noise generated inside the park includes not only visitor noise (such as vehicles, dogs, and voices), but noise generated by park staff (vehicles, power equipment, and voices). Baseline studies should be done to quantify ambient noise within the park, and the value of natural quiet should be incorporated into park planning, operations and interpretation.

4 GGNRA NATURAL RESOURCE PROGRAM

The magnitude and visibility of the threats to natural resources at GGNRA require the combined efforts of all park and community resources to properly care for the multitude of resource values. The staff of the Division of Natural Resources Management and Research serves as natural resource project managers and as consultants to the park on issues regarding each specific expertise. This professional staff works as an interdisciplinary team. The blending of disciplines and skills allows for an ecosystem approach to problem solving. The focus of the program is to promote the health and vitality of the natural resources and the systems/processes they require.

All other divisions also contribute to natural resources management. The Division of Maintenance controls erosion and vegetation throughout the park in trail and road projects and monitors resource conditions daily, with other routine maintenance responsibilities. Resource and Visitor Protection staff ensures that recreational users do not abuse sensitive sites, and they report resource damage. The Interpretive staff facilitates community and visitors awareness of the fragile resources and the actions that the park takes to preserve and restore them.

Alliances with thousands of volunteers provide the experience of hands-on resource preservation projects and produce field results that would otherwise be impossible, given limited staffing. The Golden Gate National Parks Association provides the vehicle to tap these community resources through staff and outreach programs. The Golden Gate National Parks Association also provides professional grant writing, planning, and natural resource project support.

The Division of Natural Resources Management and Research consists of the following positions: Ecologist, Hydrologist, Natural Resources Management Specialist (Wildlife), Integrated Pest Management Specialist, Aquatic Ecologist, two Plant Ecologists, two Natural Resources Management Specialists (Vegetation), and a Geographic Information System Specialist.

4.1 Objectives of the Natural Resource Program

The program is complex, and spans many disciplines and divisions. The goals of the program are generally to know, restore and maintain the natural resource values of the park. More specifically, the following goals are identified:

1. Increase basic knowledge of the park's natural resources, to address threats and restore natural conditions.
2. Practice an interdisciplinary, ecosystem management approach to natural resources management and protection, transcending park boundaries where possible.
3. Strengthen community awareness and participation in resources management by interdivisional and interdisciplinary structure.
4. Pro-actively identify and manage potential conflicts between natural resources and human uses through data collection, education, and development of management alternatives to protect and restore resources where necessary.
5. Protect or restore and monitor the natural biological diversity of the park's ecosystems including but not limited to threatened, endangered, and sensitive species, and their habitats.

6. Improve water quality in the park through identifying and mitigating point and non-point pollution, identifying and mitigating illegal and unnecessary water withdrawals, restoring damaged water habitats and monitoring water quality attributes in sensitive park streams.
7. Prevent loss of native species and habitats by eliminating or controlling non-native and feral species populations.
8. Integrate natural resources data collection and management with GIS technology and standardize systems.

The Natural Resources Program has a global view of natural resources conservation and incorporates it into the planning and day-to-day operations. Sustainable design and innovative technologies broadens the natural resources program to a global focus. Water conservation, recycling, use of recycled products, integrated pest management and the reduction of pesticides are all embodied in the natural resource program. This vision is reinforced through the vision of the Presidio *General Management Plan Amendment*.

4.2 Inventory and Monitoring (Vital Signs) — an Integrated Program

This program will be implemented within the next 5 years if funding and staffing are available. A Vital Signs Plan will be an addendum to this document.

4.3 Restoration — an Integrated Program

Restoration of natural systems is a major element of the natural resources management program of the park. The NPS and the GGNRA partner with community volunteers and other agencies to incorporate a variety of ways to enhance natural processes through habitat restoration. Projects vary from watershed-wide programs that include many facets and agencies to smaller projects that focus on revegetation but provide valuable habitat for a rare species such as mission blue butterfly, or general wildlife services. Although this kind of project may appear to focus on vegetation, wildlife volunteers and interns would monitor the project to assess the way the plant community and associated wildlife evolve. Most of these simple projects are overseen by the vegetation program and are reviewed in Section 4.6, even though wildlife interns and volunteers are coordinated with an integrated approach.

More complicated watershed programs are identified here. They include hydrologic, aquatic, vegetative and wildlife habitat restoration as well as more indirect ecological conservation and restoration such as sustainable practices and transportation issues. Often these issues are coordinated by watershed and involve the following:

1. Long-term multifaceted projects both within and beyond park boundaries.
2. Day-to-day project awareness, communication and integration.
3. Integration into other park operations.
4. Integration outside park boundaries.
5. Water conservation, recycling, sustainable design.

4.3.1 Redwood Creek Watershed

This watershed crosses jurisdictional boundaries of California State Parks, Marin Municipal Water District, the Muir Beach Community and Green Gulch Farm, in addition to GGNRA. The watershed itself is unique with towering redwood habitats, rare salmon migrations, monarch butterflies, spotted owls and aquatic habitats. The potential for improving the status of sensitive ecosystems in this watershed are great; the threats to the system are great as well. Water diversions, erosion, stable operations, development, non-native plant invasion, farming, habitat fragmentation and degraded water quality all weaken the integrity of the watershed ecosystem.

An interdisciplinary, interagency cooperative working group was created in 1998 to facilitate watershed management. It represents an alliance of private property owners and land management agencies for sensitive and sustainable management operations.

Project statements directly related to this project include:

GOGA-N-005	Redwood Creek Watershed Restoration Project
GOGA-N-032	Old Growth Forest Species Protection
GOGA-N-048	Water Quality Monitoring Program
GOGA-N-081	Coho Salmon and Steelhead Preservation and Restoration
GOGA-N-082	Control of French Broom
GOGA-N-002	Survey and Mitigate Erosion
GOGA-N-012	Big Lagoon Restoration
GOGA-N-020	Inventory and Monitor Aquatic Resources
GOGA-N-001	Control Alien Plant Species
GOGA-N-016	Revegetation and Nursery Management

4.3.2 Rodeo Lagoon Watershed

Rodeo Lagoon is the only estuarine resource which has its watershed completely within the park boundary. A comprehensive restoration project for the lake, lagoon, and watershed environs is necessary. Actions of this project will include: monitor lagoon fish community; investigate the effects of poor water quality on ecology of Rodeo Lagoon; monitor and mitigate water quality and erosion, inventory and monitor other sensitive species, restore habitat and correct wildlife disturbance problems. Several project statements will be implemented to begin to accomplish this goal:

GOGA-N-180.001	Tidewater Goby Research (Investigation of poor water quality on the ecology of Rodeo Lagoon, Marin County, California)
GOGA-N-019.000	Tidewater Goby Monitoring
GOGA-N-002.000	Capehart Quarry
GOGA-N-004.000	Mission Blue Butterfly Habitat Restoration

4.3.3 Lobos Creek Restoration

The Lobos Creek Valley is identified as “Nature’s Quiet Refuge” in the *General Management Plan Amendment* for the Presidio (NPS 1994). Lobos Creek provides water to the Presidio as well as to four native plant communities that are adjacent to it. The creek is to be restored as a naturally flowing stream and the valley preserved as a wild area. Plant habitats along the creek and in the adjacent dunes that house rare plants are to be restored. The cultural forest in the area will be preserved. The vision is to provide opportunities to learn about natural systems and sensitive human use of resources. Therefore visitor access must be accommodated conservatively. Threats in the area include: water diversion management, water quality impacts from the surrounding urban area, visitor recreation impacts, non-native plant

invasion, past land use practices such as tree plantings, dredging of the creek, construction of a ball field and a road and sewer management.

4.3.4 Bolinas Ridge Range Management

GGNRA range management consists of three horse stables, a small range of goats and sheep at Slide Ranch, and a set of cattle ranges that are administered by Point Reyes National Seashore. Range practices impact the hydrology and soils by vegetation removal, compaction, and nutrient changes from manure and urine. Water is retrieved for cattle consumption, often by wells, lowering the water table. Native wildlife is affected by grazing and recent park surveys have found that wildlife biodiversity is decreased in grazed areas.

The strategies to remedy these issues vary. Horse stable issues are addressed through the stable permits and long-term site planning. The Slide Ranch site plan includes range management. The northern grazed lands administered by Point Reyes National Seashore will be jointly managed with the seashore. A Range Management Specialist on the Point Reyes staff is implementing the *Range Management Guidelines* for Point Reyes and the park's northern lands. GGNRA staff will assist in implementing those guidelines when appropriate. Initial focus will be put on overgrazing, riparian protection, water management and cultivated areas. Quarterly meetings with Point Reyes Natural Resource staff will facilitate this management effort.

Guidance for this management is led through the Range Management Guidelines and identified in Project Statement GOGA-N-024.

4.3.5 Water Conservation, Recycling, Sustainable Design

The projects under this heading address many ideas expressed in the NPS's publication *Guiding Principles of Sustainable Design*. The goal of projects under this category is to create within GGNRA a model of environmental sustainability. This can be achieved by improving energy efficiency, using environmentally sensitive materials, conserving water, recycling materials and serving as a model of stewardship and wise use of global resources.

Threats associated with not developing this program include lowered water tables, polluted air, loss of topsoil, deforestation, extinction of plants and animals, overexploitation, solid waste and landfill overflow, and general degradation of our environment.

Strategies for addressing these threats are all based on reducing consumption. Specific water conservation strategies include using low-flow toilets (toilets are the largest household water use), developing efficient irrigation systems, using drought-tolerant landscaping, hooking up to reclaimed water systems, identifying leaks in piping, and educating water users. Another strategy is to develop demonstration areas at locations such as the Presidio Golf Course, Muir Beach, and Fort Mason. Tenants and other park partners should be required to comply with this program.

4.3.6 Day-to-Day Project Awareness

Ongoing interdivisional communication is necessary to ensure the best management practices in natural resources management. Personal communications and daily access to phones, radios, electronic mail and personal contact is critical to an integrated, unified program. Intradivisional communications through posting of activities and achievements in Buildings 1061, 102 and 201 are encouraged. Protection, Maintenance, and the Golden Gate National Parks Association are continually updated about changes in threats and resource condition through the vehicles noted above.

The Division of Interpretation is the conduit between the natural resources branch and the public. Continuing information exchange between interpretation and natural resource management regarding ongoing and one-time projects will promote a community of support and understanding of natural resource issues and management.

Projects throughout all divisions of the park are communicated through a Project Review process. The Division of Planning and Compliance is responsible for the review of projects. The Division of Science and Natural Resources participates in the Project Review process. In this way the possible impacts of any initiated project can be mitigated at the planning stage.

4.3.7 Integration Outside Park Boundaries

The staff works with federal, state and local agencies to ensure an ecosystem approach to natural resource problems. Land manager groups meet to discuss mutual concerns and to coordinate strategies for problem solving. A GGNRA representative sits on the Bolinas Lagoon Technical Advisory Committee and on the Tomales Bay Advisory Committee. A recent agreement with California State Parks initiates a joint management program on state park lands throughout the park.

Projects outside park boundaries come to the natural resource staff through the Branch of Planning and Compliance. Interdisciplinary teams are generally assigned through Project Review to review the projects. Natural resource concerns are addressed through that process.

4.4 Wildlife Program

Fifty-three terrestrial wildlife species occurring within the park are federally or state listed, proposed for federal listing, or are state or federal species of concern. A major emphasis of the park's wildlife program is to inventory, monitor, protect and restore the park's sensitive wildlife resources at the population, watershed or ecosystem level. These efforts are often undertaken on a cooperative basis with adjoining state and national parks and local land management agencies. Additional aspects of the park's wildlife program include resolution of human/wildlife resource conflicts, monitoring and control of feral and non-native animal populations and associated impacts to native wildlife and ecosystems, and wildlife data management.

Additional non-NPS components of the park's wildlife program include the Golden Gate Raptor Observatory, funded by the GGNPA, and the Golden Gate Field Station of the USGS Biological Resources Division's California Science Center.

The following projects detail GGNRA's strategies for addressing major threats to the park's wildlife resources and for achieving its wildlife program objectives.

4.4.1 Western Snowy Plover Protection and Monitoring

Ocean Beach has been a popular recreation area in the midst of the city of San Francisco for more than a century. Ocean Beach is also home to the western snowy plover (*Charadrius alexandrinus nivosus*), whose numbers have been greatly reduced in recent years, primarily as a result of habitat loss. The U.S. Fish and Wildlife Service (USFWS) listed the Pacific coast population of this diminutive shorebird as a "threatened" species in 1993.

Between 15 and 85 non-breeding snowy plovers live on Ocean Beach for 10 months of the year. They are subjected to intense recreational pressure and disrupted by off-leash dogs, and may be impacted by GGNRA and City and County of San Francisco (CCSF) operations including vehicle patrols and shoreline stabilization projects. The park has developed a draft management plan that addresses all

activities with the potential to adversely affect snowy plovers on Ocean Beach and prescribes measures to minimize those impacts. The proposed management actions are in addition to those measures already implemented, such as enforcement of existing NPS leash regulations and changes in operation of heavy equipment. Snowy plovers occur from south of Fulton Street in the north, to Sloat Boulevard approximately 2 miles to the south.

Ocean Beach today represents a highly constructed and manipulated beach environment influenced by a combination of natural processes and human-induced influences on those natural processes. Little historical information is available on snowy plover use of Ocean Beach. It probably nested on the beach before development and extensive habitat alteration, but no records document actual nesting. Statewide censuses of wintering snowy plovers were conducted in California and Oregon by Point Reyes Bird Observatory volunteers between 1979 and 1985. Ocean Beach was surveyed 26 times over that period, yielding annual median counts of from 2 to 14 snowy plovers, with the wintering population estimated to be 14 plovers in San Francisco County (all on Ocean Beach). Maximum counts each year ranged from 4 to 16 plovers.

Following the listing of the western snowy plover as a threatened species in 1993, the park implemented a twice-weekly monitoring program with the following objectives:

1. Determine the current and long-term population status and trend in snowy plover use of Ocean Beach;
2. Determine the spatial distribution of snowy plovers on Ocean Beach;
3. Determine current levels and patterns of use by people and dogs on Ocean Beach;
4. Document current levels of disturbance, from all sources, to snowy plovers on Ocean Beach; and,
5. Document changes in behavior by people and dogs, and changes in disturbance levels following implementation of snowy plover protection measures.

Monitoring protocols are described in the park's Snowy Plover Monitoring Plan. Results from the first two years of the monitoring program are detailed in a monitoring report. Some of the findings are described below.

Surveys conducted by Point Reyes Bird Observatory, GGNRA, and an interested citizen between 1988 and 1996 observed annual median counts of from 20 to 40 snowy plovers, for a mean annual median of 28 snowy plovers for the entire period. Maximum counts each year ranged from 38 to 85 birds during this period. Snowy plovers were found on Ocean Beach from early July through mid-May, but none were present during the height of the breeding season between mid-May and July 1.

The 100 percent increase in the number of snowy plovers between the early 1980s and early 1990s correlates well with a period of beach widening and beach nourishment between 1985 and 1992. Beach profile and shoreline position data indicate an erosional trend occurred in the 1970s and early 1980s, resulting in a relatively narrow beach profile during that period. In 1992, Ocean Beach was near its historic widest, largely due to human activity. More suitable plover habitat appears to be available when the beach is wider. Beach width has narrowed considerably since 1992 with a corresponding decline in the number of plovers using Ocean Beach. Snowy plover numbers dropped to a maximum of 25 to 35 in 1998 and 1999, following two winters of severe storms and coastal erosion. Other factors that probably influence the annual fluctuations in the wintering population of snowy plovers at Ocean Beach include loss of habitat in San Francisco Bay (e.g., changes in salt evaporation pond management) and changes in habitat conditions elsewhere.

The park also conducted a disturbance study of snowy plovers on Ocean Beach from 1994 to 1996 that documented that beach users with off-leash dogs disturbed plovers at a greater frequency than users without dogs, and that plovers were disturbed at greater distances by users with dogs.

A snowy plover management plan is being developed, based upon findings of the long-term monitoring program. Though not finalized, all elements of the plan have been implemented. The advent of seven drownings on Ocean Beach during the summer of 1998 led to changes in the public safety program on the beach and an increase in vehicle patrols during the warmest months of the year. These changes, and their impact on snowy plovers, are currently being addressed and added to the management plan.

The specific objectives of the snowy plover management plan are to:

1. Provide background information on public use, and GGNRA and CCSF operations that may affect snowy plovers and their habitat on Ocean Beach.
2. Recommend management actions that will prevent and minimize disturbance to snowy plovers on Ocean Beach, while continuing to provide for compatible recreational experiences for the local community and visiting public.
3. Recommend management actions that will prevent and minimize snowy plover habitat degradation, and promote long-term protection and enhancement of snowy plover wintering and migratory shorebird habitat.
4. Provide for protection and accessibility of GGNRA and CCSF resources, facilities and infrastructure in a manner compatible with the long-term protection of snowy plover wintering and migratory shorebird habitat on Ocean Beach.
5. Ensure public safety.

Additional changes may be required if Ocean Beach is added to snowy plover critical habitat. GGNRA's draft management plan is considered a model by USFWS and the recovery team for management of wintering snowy plover habitat. USGS Biological Resources Division is also modeling a research project, Science-Based Recovery Goals for Wintering Snowy Plovers, after the disturbance monitoring program conducted by NPS at Ocean Beach.

Project statements related to snowy plover monitoring and protection include:

GOGA-N-090	Western Snowy Plover Management
GOGA-N-018	Monitor Beach Erosion
GOGA-N-025	Monitor Marine and Estuarine Resources
GOGA-N-006	Resolve Human/Natural Resources Conflicts
GOGA-N-074	Avian Resource Inventory

4.4.2 Northern Spotted Owl Inventory, Monitoring and Protection

Golden Gate National Recreation Area, Muir Woods National Monument, and Point Reyes National Seashore began a joint systematic survey for northern spotted owls (NSOs) in Marin County in 1993. The surveys were designed to systematically inventory forested public lands within and surrounding national parklands for spotted owls, and determine occupancy and reproductive success to the extent feasible. Previously, there had been a few informal surveys in the area, but only one pair was reported in the Northwest Forest Plan.

Spotted owl inventory and monitoring by the NPS in Marin County includes public lands within GGNRA, Muir Woods, Point Reyes National Seashore, Mt. Tamalpais State Park, Samuel P. Taylor State Park, and Tomales Bay State Park, and is coordinated with the Marin County Open Space Reserves and Marin Municipal Water District.

These parks are situated within the immediate San Francisco Bay Area and receive several million visitors per year. Development pressures along the park borders result in habitat conversion and disturbance. The NPS Fire Management Program intends to increase the number and size of prescribed burns, and to remove vegetation to construct miles of fire breaks along Point Reyes, GGNRA and Muir Woods boundaries because of concern about wildfires along the urban/wildland interface. Because this population is geographically isolated, it may also be genetically isolated from other NSO populations. The barred owl, a known predator of NSOs, is currently reported 35 miles north of the GGNRA/Point Reyes National Seashore borders and likely will occur in the parks within the next few years.

The parks completed NSO inventory of parklands in 1998 and initiated a demographic study and color-banding of spotted owls. Study objectives include:

1. Quantify population demographics on a nest-site basis over 5 years (nest site occupancy, turnover rate, survival/dispersal, reproductive rates),
2. Reduce habituation of NSOs through modified survey protocols,
3. Quantify the known and predicted distribution and density of owls through GIS spatial analysis and habitat modeling,
4. Characterize habitats around owl nest sites through GIS spatial analysis, relate population demographics to habitat characteristics, and
5. Design robust, habitat-based protocols to monitor the long-term health of NSOs within GGNRA, Muir Woods, and Point Reyes National Seashore boundaries.

GGNRA wildlife staff will continue to coordinate the spotted owl demographic monitoring project as a cooperative effort (supplemented by volunteer support) on lands within GGNRA, Point Reyes National Seashore, Muir Woods National Monument, and California state parks (in five state parks). NPS will coordinate survey efforts with Marin County Open Space District, and the Marin Municipal Water District. Grant funding through the National Park Foundation Canon Expedition into the Parks, and the Marin Audubon Society was obtained to partially support this project (NPS GS-7 bio-tech and Point Reyes Bird Observatory contract) through 2000. After that time a 0.5 full-time position (FTE) GS-7 bio-technician and an intern, as well as shared support for Point Reyes Bird Observatory with Point Reyes National Seashore will be needed to support long-term demographic monitoring.

Project statements directly related to northern spotted owl inventory, monitoring and protection include:

GOGA-N-032	Old Growth Forest Species Protection
GOGA-N-032.002	Spotted Owl Monitoring
GOGA-N-006	Resolve Human/Natural Resources Conflicts
GOGA-N-074	Avian Resource Inventory
GOGA-N-007	Vegetation Inventory Monitoring
GOGA-N-014	Geographic Information System Development
GOGA-N-0003	Prescribed Fire Program
GOGA-N-003.001	Impacts of Prescribed Fire on Terrestrial Vertebrates and Native Vegetation

4.4.3 Mission Blue Butterfly Monitoring and Protection

Prior to European settlement of the San Francisco Bay Area, the mission blue butterfly (*Plebejus icarioides missionensis*) was thought to have occurred throughout the coastal scrub habitat of the San Francisco peninsula. Its distribution is now restricted to three known areas: San Bruno Mountain (San Mateo County), the Skyline ridges, including Milagra and Sweeney ridges within GGNRA (San Mateo County), and the Marin Headlands (Marin County). Although not well documented, this dramatic decline is almost certainly due to two factors: habitat fragmentation and loss resulting from urban development, and habitat degradation due to increasing dominance of non-native plant species.

In 1976, the mission blue subspecies was listed as endangered by the USFWS and has since been listed as endangered by the CDFG. Although little is known about the ecology of this butterfly, preliminary studies have been conducted on populations on San Bruno Mountain. Based on this work, an influential Habitat Conservation Plan was developed that has served as a model for the management of endangered taxa.

In response to its endangered status, GGNRA initiated a broad-scale habitat restoration program removing French broom and pampas grass throughout its habitat in the park during the late 1980s and early 1990s. In 1994, the park initiated a long-term mission blue butterfly monitoring program at Milagra Ridge and Marin Headlands. A total of 30 permanent transects were installed in the park. Butterflies are surveyed using the low-impact Pollard technique where butterflies are counted, sex and behavior recorded within a timed, walking belt transect. Weather data is also collected at the start of each transect.

This systematic effort is providing valuable baseline data that will allow resource managers to assess the effectiveness of efforts to sustain viable populations of the mission blue butterfly. Long-term data also provides a foundation for more in-depth ecological studies of endangered species. The monitoring methods employed at GGNRA have recently been adopted at other mission blue sites in San Mateo County.

Five consecutive years of mission blue butterfly monitoring have been completed with annual reports compiled for each year for Marin Headlands and Milagra Ridge. Results indicate that precipitation regimes and ambient air temperature influence butterfly abundance and phenology. 1998 mission blue butterfly abundance was the lowest in 5 years, coincident with El Niño conditions with elevated winter and spring rainfall. The butterfly's host plant, the lupine, experienced significant die-back throughout the butterfly's range, probably due to a pathogen encouraged by the heavy rains. Long-term monitoring will allow resource managers to determine the long-term impact of the lupine die-back on butterfly abundance. GIS analysis allows park managers to assess host plant die-back, non-native plant invasion, and butterfly abundance.

The mission blue butterfly continues to be threatened by development adjacent to park boundaries, fragmentation of remaining habitat, visitor use impacts including social trails, past land use practices, erosion, invasion of non-native plant species, maintenance of park roads and trails, development of new trails, law enforcement activities, and changes in the natural fire regime within the park.

Project statements directly related to mission blue butterfly protection and monitoring include:

GOGA-N-004	Mission Blue Butterfly Habitat Restoration
GOGA-N-004	Mission Blue Butterfly Habitat Restoration – Marin Headlands
GOGA-N-004	Mission Blue Butterfly Habitat Restoration – Milagra Ridge
GOGA-N-004	Mission Blue Butterfly Habitat Restoration – Butterfly Monitoring
GOGA-N-001	Control Alien Plant Species

GOGA-N-006	Resolve Human/Natural Resources Conflicts
GOGA-N-014	Geographic Information System Development

4.4.4 Bank Swallow Monitoring and Protection

The short- and long-term viability of the bank swallow (*Riparia riparia*, a state-listed threatened species) colony at Fort Funston is threatened by accelerated cliff erosion from visitors climbing and carving graffiti in the cliff face, visitors hiking in closed areas, shoreline stabilization projects, accidental hang-glider overflights, overflights of helicopters and small planes, possibly unnaturally elevated numbers of predators (American kestrels) and competitors (European starling) using manmade perches and nest-sites, sea-level rise, and natural coastal erosion.

Approximately 50 percent of bank swallow habitat in California has been lost, primarily due to river bank stabilization. The Fort Funston colony is one of only two colonies along the California coast. The park has made significant efforts to protect the colony from disturbance, but its location makes complete protection from visitor impacts impossible.

A long-term monitoring program conducted by park staff and volunteers was established in 1993 to look at year-to-year variation in bank swallow use of the colony, measure productivity of the colony, document predation and human disturbance levels, and determine long-term trends in occupancy and reproductive success. The precision of the population monitoring is limited by use of unobtrusive survey methods, dictated by the fragile and inaccessible nature of the cliffs. Photo-monitoring is conducted each year before and after breeding season and photos are archived to preserve a long-term record of colony use. The extent of the colony is also mapped in the park's GIS and changes are recorded each year.

“Baseline” physical parameters of the site (cliff height, slope, and length) need to be measured and cliff erosion rates throughout the colony need to be surveyed periodically to predict the physical longevity of the colony. Park natural resource staff will continue to conduct this monitoring project using volunteers. Additional wildlife staff support (0.2 FTE Biological Technician) is needed to assist in coordination, to provide quality assurance, and further refine methodologies.

Project statements directly related to bank swallow protection and monitoring include:

GOGA-N-021	Protect and Manage Bank Swallow Population
GOGA-N-006	Resolve Human/Natural Resources Conflicts
GOGA-N-018	Monitor Beach Erosion

4.4.5 Alcatraz Island Wildlife Monitoring and Protection

Alcatraz Island supports the most diverse assemblage of marine and estuarine colonial nesting waterbirds in San Francisco Bay and some of the most significant wildlife resources within GGNRA. San Francisco Bay's only colonies of pelagic and Brandt's cormorants, and pigeon guillemots occur on the island. The western gull colony is one of the largest along the central coast of California, and the black-crowned night-heron colony is one of the largest in the greater San Francisco Bay region. Great egrets, snowy egrets and black oystercatchers have all recently begun nesting on the island.

Colonial nesters generally breed in isolated, inaccessible mainland locations, or on little-inhabited islands, where they can avoid disturbance that can result in colony abandonment or total reproductive failure. Alcatraz Island is the only San Francisco Bay island supporting colonial waterbirds that is open to the public and receives 1.4 million visitors per year. At least two “undisturbed” San Francisco Bay island colonies have been recently abandoned by night-herons and egrets.

Colonial nesting waterbirds also serve as important biological monitors of the health of estuarine ecosystems. They are high in the food web and may reflect contamination in a variety of ecosystem components. Previous studies of San Francisco Bay wildlife, including black-crowned night herons in San Francisco Bay and on Alcatraz, have found elevated levels of organochlorine pesticides and heavy metals at levels associated with reproductive impairment.

Several other bird species also nest on Alcatraz, including Anna's hummingbird, Canada goose, common merganser, common raven, fox sparrow, house finch, mallard, song sparrow and white-crowned sparrow. One amphibian, the California slender salamander, and one native mammal, the deer mouse, inhabit the island. A color variant of the deer mouse occurs on part of the island and may be unique to Alcatraz. The introduced Norway rat was discovered on the island in 1998.

Wildlife resources on Alcatraz Island are imminently threatened by an array of existing, impending, potential, and cumulative internal and external threats and pressures.

With the advent of increased NPS funding for Alcatraz projects (fee demonstration program, Government Improvement Act, line-item construction), increased visitation, and increased revenues generated by the Golden Gate National Parks Association, structural stabilization and rehabilitation projects, once thought impossible, will be completed. An environmental impact statement, addressing the impact of stabilization/rehabilitation projects on Alcatraz wildlife, is in preparation.

The Alcatraz wildlife monitoring and protection program is developing and implementing projects to further preserve and protect Alcatraz' and San Francisco Bay's colonial waterbird diversity, and to educate the public about the significance of Alcatraz colonial waterbirds to biodiversity in the San Francisco Bay region. Alcatraz colonial nesters also serve as biological indicators for assessment of the long-term ecological health of San Francisco Bay.

Program components already initiated or implemented include:

- Environmental Impact Statement preparation on impacts of construction projects on colonial nesting birds and mitigations to avoid impacts and restore populations
- Long-term monitoring of Alcatraz colonial nesting birds (annual breeding populations and reproductive success)
- Development and implementation of disturbance monitoring protocols for black-crowned night-herons, western gulls and seabirds, to document and address internal and external sources of disturbance
- Western gull management to protect integrity of historic structures and human health and safety in visitor use areas
- Common raven monitoring and management to protect colonial nesting birds from unnaturally elevated levels of predation
- Norway rat eradication
- Natural resource education and interpretation

Additional program components requiring funding for development and implementation include:

- Establish an estuarine reserve or protection zone along the north, west and southwest sides of the island
- Assess environmental contaminant levels in colonial nesters as indicators of health of San Francisco Bay
- Document foraging resources utilized by Alcatraz seabirds
- Assess deer mouse genetics and restoration following Norway rat eradication
- Develop natural resource exhibits, and interpretive materials
- Determine deer mouse and slender salamander protection and monitoring needs

Project statements directly related to Alcatraz Island wildlife protection and monitoring include:

GOGA-N-013	Develop a Comprehensive Plan for Alcatraz Island
GOGA-N-013.001	Colonial Waterbird Monitoring on Alcatraz Island
GOGA-N-013.002	Western Gull Management on Alcatraz Island
GOGA-N-013.003	Norway Rat Eradication on Alcatraz Island
GOGA-N-181	Integrated Pest Management
GOGA-N-006	Resolve Human/Natural Resources Conflicts
GOGA-N-018	Monitor Coastal Erosion
GOGA-N-046	Research Marine and Estuarine Resources

4.4.6 Management of Mountain Lion/Coyote–Human Interactions

Mountain lions (*Felis concolor*) and coyotes (*Canis latrans*) both occur regularly in Marin and San Mateo counties within GGNRA. The coyote has recolonized open space and parklands after being absent for 30 years due to eradication efforts by ranchers. Protection of these species along the urban/wildlife interface requires education and management of park visitors to ensure that their interactions with mountain lions and coyotes do not jeopardize human health and safety or the well-being of these animals.

The following program is designed to achieve these goals, if funding is available. Some components of the program have been initiated, but most have not been developed or implemented due to lack of resources.

Program components include:

- Develop and implement mountain lion/coyote – human interaction management plan/standard operating procedure
- Develop an agreement with CDFG and surrounding land managers for coordinated incident response
- Formalization of the mountain lion/coyote – human interaction observation and reporting system, including training of park staff
- Update and refine interagency observation database, maintain database and GIS layer in cooperation with USGS Biological Resources Division Golden Gate Field Station
- Natural resource education and interpretation – complete mountain lion site bulletin (adapt coyote site bulletin developed by San Mateo County parks)

- Develop permanent trailhead signs on wildlife encounters and personal safety
- Train park Wildlife Biologist (and other pertinent park staff) in wildlife immobilization techniques

Project statements related to management of mountain lion/coyote-human interactions:

GOGA-N-006	Resolve Human/Natural Resources Conflicts
GOGA-N-014	Geographic Information System Development
GOGA-N-035	Urban Carnivore Study
GOGA-N-047	Monitor Rare Wildlife Species
GOGA-N-075	Terrestrial Vertebrate Inventory and Monitoring Program
GOGA-N-181	Integrated Pest Management Program

4.4.7 Rat Eradication on Alcatraz Island

Norway rats were discovered on Alcatraz Island in 1998, the first incidence known in 25 years of NPS management of the island. Rats constitute a health hazard to humans. They destroy historic structures and artifacts, as well as electrical wiring, by chewing through materials. Rats are also known to decimate native bird and rodent populations on islands. Norway rats, which dig burrows and are larger than black rats, are believed to pose a greater threat to seabirds by consuming adults, chicks and eggs, and have been implicated in the disappearance of deer mouse populations on other islands. Visitor experience on Alcatraz would also be negatively affected if the rat population increases beyond its current level.

Alcatraz Island supports one of the largest and most diverse assemblages of colonial nesting birds in San Francisco Bay. Pigeon guillemots, burrow nesting seabirds whose only breeding site within the bay is on Alcatraz, would be particularly vulnerable to rat predation as adults leave their chicks unattended in their burrows while feeding. Cormorants and western gulls are probably too large to suffer significant predation. Black-crowned night-herons, which will feed on rats, also leave their chicks unattended for extended periods of time, and may be vulnerable. Hatching and fledging rates for night-herons, which exhibit significant annual variation, have declined over the last two years, which may or may not be associated with the presence of Norway rats.

Alcatraz Island also supports native deer mice and California slender salamanders. The deer mice exhibit a well-described color morph on part of the island. It is possible that deer mice on islands within San Francisco Bay have evolved in isolation into unique genetic variants. Norway rats could cause the extirpation of deer mice on Alcatraz. The effect of Norway rats on salamander populations is unknown.

Numerous large and long-term construction projects are currently planned for seismic stabilization and rehabilitation of historic buildings on Alcatraz Island. The quantity of materials barged to and stored on the island will increase dramatically with these projects, increasing the likelihood of further rat infestations, if active management to prevent introductions is not pursued.

Implementation of a rat eradication program is critical for protection of human health, as well as protection of nationally significant cultural and natural resources.

This project will develop and implement both a plan to eradicate Norway rats from Alcatraz Island and a management plan to prevent further introductions of rats to the island. An integrated pest management approach to rat eradication will be followed, that protects island natural and historic resources, as well as human health. While most rat eradication projects have been conducted on remote, little-inhabited islands, with broadcast applications of poison baits, the presence of 1.4 million visitors a year on Alcatraz may significantly affect the choice of alternatives.

Tasks to be conducted include:

1. Conduct an island-wide assessment of the extent of the rat infestation. (Rat activity was observed in late 1998 in seabird nesting areas.) The expected impact to island resources and change in the rat population would be projected following this assessment.
2. Interim trapping using snap traps or bait blocks in enclosed traps would be continued in the most critical areas of the island.
3. Evaluate deermouse (*Peromyscus*) population genetics from Alcatraz, Angel Island (where soil is known to have been imported from) and other nearby islands supporting deermice, and from nearby mainland locations. Determine whether deermice can be reintroduced from another source if extirpated, or if a captive rearing program would be necessary for re-introductions.
4. Develop rat eradication and deermouse reintroduction plans and prepare an environmental assessment if necessary.
5. Implement rat eradication and deermouse protection or reintroduction plans.
6. Develop and implement a plan to prevent further introductions and isolation, containment and rapid eradication of re-infestations.

Project statements related to rat eradication on Alcatraz Island include:

GOGA-N-006	Resolve Human/Natural Resources Conflicts
GOGA-N-013	Develop a Comprehensive Plan for Alcatraz Island
GOGA-N-013.001	Alcatraz Island Colonial Waterbird Monitoring and Protection
GOGA-N-013.003	Norway Rat Eradication on Alcatraz Island
GOGA-N-181	Integrated Pest Management Program

4.4.8 Old Growth Forest Wildlife Species Inventory and Protection

Muir Woods National Monument contains the last remaining contiguous stand of old growth redwood forest in Marin County. Stands of old growth Douglas fir also occur upslope of the main redwood grove. This 500-acre remnant old growth forest supports the southernmost pair of breeding northern spotted owls. Old growth redwood and Douglas fir forests to the north and south also support other threatened, endangered and sensitive species that are either dependent on, or prefer old growth forest habitat. GGNRA and Muir Woods identified the need to conduct further inventory for sensitive species within Muir Woods in order to provide direction for management to better protect these remnant significant resources.

GGNRA and Muir Woods are also implementing long-term planning efforts for Muir Woods and the entire watershed. Potential future actions include re-location of the concession, visitor facilities, and parking that currently occupy a portion of Muir Woods. Other major restoration projects within and downstream of Muir Woods are in various phases of implementation or planning (coho salmon/steelhead restoration, Big Lagoon restoration, Banducci flower farm restoration, and consideration of alternatives to Redwood Creek as a water source for the Muir Beach community). This program provides a more complete characterization of the wildlife sensitivities and protection needs within Muir Woods and the watershed.

The five major components of this project were initiated in 1997 and will be completed by 2000. These include:

1. Marbled murrelet and landbird inventory
2. Bat inventory
3. Mammalian diversity inventory
4. California giant salamander inventory
5. Point Reyes mountain beaver inventory

The objectives of each component include development and implementation of baseline inventories for each of the target species groups in an effort to determine presence/absence, relative abundance, and geographical distribution of sensitive species within Muir Woods National Monument and the immediately surrounding lands. A more comprehensive understanding of wildlife species and wildlife habitat diversity will result from this project as well as protocols for long-term monitoring of old growth forest wildlife resources. Results of the project are being mapped in ArcView 3.1.

This project has been funded by NPS region funds for small park NRPP. The GGNRA Natural Resource Management Specialist (wildlife) serves as project manager for this project. Field inventories have been conducted through interagency and cooperative agreements with the USGS Biological Resources Division, and Point Reyes Bird Observatory. Additional funding will be required in the future to implement periodic long-term monitoring of old growth forest wildlife resources.

Although habitat throughout the monument is suitable for nesting of the federally threatened marbled murrelet, no positive detections have been made during murrelet inventory work. Nearshore surveys and searches for eggshell fragments beneath suitable nests trees are being conducted in 1999. Ravens and jays are known to be major predators on marbled murrelets. All corvid observations are being documented as part of this project. Thirty-five species of landbirds were detected during point count surveys in 1998. The most abundant species were the Pacific-slope flycatcher, winter wren, golden-crowned kinglet and chestnut-backed chickadee. Six landbird species are on the Audubon WatchList for California, with two of those, the band-tailed pigeon and Allen's hummingbird, on the National WatchList.

To date, mammal surveys have confirmed the presence in Muir Woods of a federal species of concern, Townsend's western big-eared bat, that had recently been found roosting in hollow redwood and bay trees in the county. Several other species of bats were also detected in Muir Woods in May 1999, including two additional federal species of concern, the Yuma and fringed myotis bat. California myotis, silver-haired and western red bats were also captured in mist-nets and released. Bat are being surveyed using mist-nets, acoustic monitoring and guano traps in hollow redwood trees. No evidence of mountain beaver activity was found during targeted surveys in 1998.

Project statements directly related to old growth forest species inventory and protection include:

GOGA-N-032	Old Growth Forest Species Protection
GOGA-N-032.002	Spotted Owl Monitoring
GOGA-N-006	Resolve Human/Natural Resources Conflicts
GOGA-N-074	Avian Resource Inventory
GOGA-N-075	Terrestrial Vertebrate Inventory and Monitoring
GOGA-N-007	Vegetation Inventory Monitoring
GOGA-N-014	Geographic Information System Development
GOGA-N-0003	Prescribed Fire Program
GOGA-N-003.001	Impacts of Prescribed Fire on Terrestrial Vertebrates and Native Vegetation

4.4.9 Avian Inventory

GGNRA and Point Reyes National Seashore share boundaries and ecologically share many species, habitats and resource issues. The two parks include more than 160,000 acres of land, 150 miles of shoreline, and around 65 vegetation classes (as identified by the California Native Plant Society classification system). In addition, the boundary of the Point Reyes National Seashore extends ¼ mile offshore in some of the most productive marine habitat in the world, where coastal upwelling provides nutrient rich waters for marine life. The two parks also include the surface waters of Tomales Bay (a 12-mile-long estuary), Drakes Estero (a 2-mile-long estuary), and portions of Bolinas Lagoon (a wetland of international significance).

Consequently, the diversity and abundance of avifauna of these parks is extraordinary, including large and rare populations of landbirds, seabirds, shorebirds and waterbirds. Located along the Pacific flyway, the region has very high numbers of resident and migratory birds. Over 438 species have been documented at Point Reyes National Seashore; 246 are categorized as rare by the “Field Checklist of Birds for Point Reyes National Seashore.” Twelve species of seabirds that nest in the region represent around half a million birds, which makes this area one of the most significant seabird breeding areas south of Alaska.

Substantial amounts of data have been collected on birds in this region for more than a century, including 36 continuous years of landbird data collected by the Point Reyes Bird Observatory. Nevertheless, systematic and coordinated surveys have not been conducted between the parks until the last few years, and many areas within the parks have not been inventoried. During an inventory and monitoring scoping session in 1996, the parks identified avifauna as a major component of ecosystems to be inventoried and monitored.

The overall goal of this project is to document avian species distribution, relative abundance, and species richness and diversity in all of the major habitats in three national parks of the San Francisco Bay Area. GGNRA will provide a sound scientific-based inventory of all major groups of birds that breed and winter in parks. Information gathered will help identify important areas, habitat features, and landscapes that support viable and diverse bird populations. Results from the inventory will provide a basis for development of a long-term monitoring program. This project will not inventory seabirds in the three coastal parks; this is a task that is partially being completed under other studies but additional work will be required to complete a comprehensive inventory.

Project objectives include:

1. Document distribution, relative abundance and species richness of avifauna in the major habitat types (around 50).
2. Document 90 percent of breeding landbird species and describe their habitat associations.
3. Document 90 percent of winter shorebirds and describe their habitat associations.
4. Document 90 percent of winter waterbirds and describe their habitat associations.
5. Develop distribution maps for 80 percent of the species breeding in the parks and for the abundant wintering species.
6. Provide summary information for developing a conceptual long-term monitoring plan for breeding landbirds and wintering shorebirds and waterbirds.

Inventory plots will be coordinated with other inventory efforts in the parks, include small mammal and vegetation inventories.

Related project statements include:

GOGA-N-074	Avian Resource Inventory
GOGA-N-074.001	Riparian Bird Monitoring
GOGA-N-006	Resolve Human/Natural Resources Conflicts
GOGA-N-075	Terrestrial Vertebrate Inventory and Monitoring
GOGA-N-007	Vegetation Inventory Monitoring
GOGA-N-014	Geographic Information System Development
GOGA-N-0003	Prescribed Fire Program
GOGA-N-003.001	Impacts of Prescribed Fire on Terrestrial Vertebrates and Native Vegetation

4.4.10 Riparian Landbird Monitoring and Protection

Declines in North American songbird populations, particularly those that breed in North America and migrate to the neotropics, have received considerable attention in recent years (Hagan and Johnston 1992). Variation in reproductive success has been suggested as a major cause of population declines of neotropical migrants. Understanding the impact of non-native plant species on breeding songbirds as well as collecting baseline information to evaluate restoration efforts will help reverse these declines. National parks have been considered the most important areas in which to conserve and monitor biotic communities as ecological reference sites (Dasmann 1972).

This project will supplement an existing songbird monitoring project initiated by the Point Reyes Bird Observatory with the GGNRA in 1997 (Gardali and Geupel 1997). Initial results of songbird monitoring within the Redwood Creek watershed indicate that nest success of the four most common neotropical migrant and resident songbirds (Swainson's thrush (*Catharus ustulatus*), warbling vireo (*Vireo gilvus*), Wilson's warbler (*Wilsonia pusilla*), and song sparrow (*Melospiza melodia*) is exceptionally poor as compared to similar watersheds in coastal Marin County.

This purpose of this project is to conduct monitoring and habitat assessment to determine the impacts of non-native Cape ivy (*Dolaisia odorata*), formerly referred to as German ivy (*Senecio mikanioides*), and its removal, on riparian songbirds. Baseline data will be collected to allow the success of riparian habitat restoration to be evaluated in relation to songbird diversity, abundance and nesting success. Habitat and floristic data will be analyzed to develop specific restoration recommendations to improve riparian breeding habitat. Removal and containment of Cape ivy has been identified as the highest natural resource management priority within the GGNRA because it has been shown to cause a reduction in the abundance of several orders of insects and a decrease in plant species richness. Cape ivy is spreading most rapidly within riparian corridors that provide habitat critical to several endangered aquatic species (NPS, GOGA-N-074). Rapidly expanding infestations of Cape ivy may also negatively affect the breeding productivity of landbirds.

Impacts to songbirds, habitat assessment, and development of riparian restoration recommendations will be accomplished by comparing bird response and associated habitat characteristics on three permanent plots (an existing Cape ivy containment plot, a plot heavily infested with Cape ivy identified for complete eradication beginning in 1998, and a reference plot relatively undisturbed by Cape ivy) along Redwood Creek and to similar watersheds in coastal Marin County. Continued monitoring in future years would provide valuable insight into long-term breeding bird response to riparian restoration efforts.

Bird monitoring and habitat assessment will address four objectives that will facilitate GGNRA riparian restoration and management:

1. Provide baseline data on species richness, diversity, abundance, and nesting success by which changes made to the watershed (Cape ivy removal and habitat restoration) can be measured over time.
2. Evaluate how vegetation structure and composition influence nest site selection and nest success.
3. Provide specific recommendations for restoration to improve riparian breeding habitat within the Redwood Creek Watershed.
4. Evaluate the success of Cape ivy removal and habitat restoration efforts relative to breeding bird species richness, diversity, abundance, and nesting success.

Special attention will be given to four species during nest monitoring: Swainson's thrush, warbling vireo, Wilson's warbler, and song sparrow. Three of the species are understory nesters, and one (warbling vireo), is a canopy nester. These species are all statewide riparian priority species as defined by California Partners in Flight; the song sparrow, Swainson's thrush, and Wilson's warbler are the most abundant species breeding on our Redwood Creek nest plots, and by including the canopy-nesting warbling vireo, the response of understory-nesting species can be compared/contrasted with that of a canopy nester. These four species are among the most abundant species in riparian areas of coastal Marin County and have a high percent mean similarity in proportional abundance between all Point Reyes Bird Observatory study sites in GGNRA and Point Reyes National Seashore, enabling an increase in sample size and statistical power for data analysis.

Habitat assessment is conducted at all nest site locations, 24 random locations, and all point count stations during the breeding season to establish relationships between population parameters and vegetation variables. Methods follow the Breeding Biology Research and Monitoring Database protocol for nest sites (Martin and Conway 1994). Vegetation at each point count station will be assessed using a relevé, a plot of 50-meter radius centered on the census point.

Recommendations for riparian restoration were generated by correlating habitat assessment variables with nest monitoring and point counting information at Redwood watershed and other similar watersheds in coastal Marin County, and will be further refined as additional data are available.

Project statements related to riparian landbird monitoring and protection include:

GOGA-N-074.001	Riparian Bird Monitoring
GOGA-N-074	Avian Resource Inventory
GOGA-N-001.006	Control of Alien Plant Species – Cape Ivy
GOGA-N-006	Resolve Human/Natural Resources Conflicts
GOGA-N-007	Vegetation Inventory Monitoring
GOGA-N-014	Geographic Information System Development
GOGA-N-038	Develop Riparian Zone Management Guidelines

4.5 Integrated Pest Management (IPM)

A comprehensive integrated pest management (IPM) Program has yet to be developed at the park, although a plan for the Presidio was completed in 1996 and 1 FTE, a WG-10 Pest Controller reporting to the Division of Natural Resources Management and Research, has been dedicated to integrated pest management on the Presidio since 1997.

Park-wide IPM program needs include management of pest problems affecting structures, developed lands, natural areas, cultural resources, historic forests, wildlife populations, and human health and safety. A wide variety of non-native animals, vertebrate and invertebrate pests, non-native plants, and disease organisms affect rare and endangered plants and animals that inhabit the park, structural integrity of historic and non-historic buildings, and trees, creating potentially hazardous conditions to life and property.

Feral, non-native, and unnaturally elevated populations of native animals affect human health and safety as well as natural and cultural resources throughout the park. Non-native problem animal species include Norway and black rats, feral cats, feral hogs, wild turkeys, starlings, and typical developed area pests. Unnaturally elevated native animal populations include skunks and raccoons in developed areas, western gulls in visitor use areas of Alcatraz Island, common ravens and other corvids, and woodrats invading buildings in Muir Woods.

The scope of integrated pest management needs in the park is extremely broad and includes concession-operated food services, a golf course, horse stables, a multitude of park partners and their associated facilities and programs. Examples include marine mammal care facilities, laboratories, gardens and museums.

The park is committed to innovative technologies and sustainable design practices to support a strong integrated pest management philosophy. The park follows the guidance in NPS-77 in addressing IPM program needs, and will strive to adhere to new guidelines as they are developed.

4.6 Vegetation Program

The park's Vegetation Management Program is a multifaceted, community-based stewardship program that emphasizes the inventory, monitoring, protection, restoration and rehabilitation of the park's diverse vegetation resources at the population, watershed and/or ecosystem level. These efforts are often undertaken through establishing partnerships with adjacent land management agencies, local universities, colleges, and school districts, non-profit community organizations, park partners, local and national conservation and community corps, and state and national environmental organizations. Aspects of the vegetation management program include vegetation data management; invasive non-native plant control and management; vegetation and restoration-based resource education program delivery and coordination; rare plant monitoring; research; community-based stewardship program coordination; and native plant propagation and nursery management.

The Vegetation Management (Stewardship) Program has two primary goals:

- To implement a scientifically based ecological restoration program in disturbed park lands, protecting, enhancing and restoring the park's native vegetation communities, with emphasis on populations of rare or endangered species, rare plant communities and special ecological areas, as well as controlling the highest priority invasive non-native plant threats impacting the park's ecosystems.
- To create and foster a volunteer program that serves community needs for ecological recreation and builds a constituency around an ethic of ecological restoration and stewardship through teaching people, especially youth, concepts of community, ecology, and restoration practices using the park's ecosystems as hands-on experiential classrooms.

The following is an overview of GGNRA's Vegetation Management Program (Vegetation Stewardship Program) and strategy for achieving the program's goals.

4.6.1 Habitat Restoration Through Community Stewardship Programs

A variety of past and current land uses (e.g., quarry construction, trail and road corridor development, parking lot and infrastructure construction, ornamental vegetation plantings, leach field installation, grazing, filling of wetlands, suppression of fires, and diverse recreational use) have converted approximately 10 percent of the park's once ecologically rich native plant communities to the status of "disturbed" lands. The need to prevent further impacts, and to incrementally convert disturbed lands to functioning native communities, has resulted in the development of GGNRA's large-scale community-based habitat restoration efforts.

The habitat restoration component of the Vegetation Stewardship Program currently consists of four key program elements: the Site Stewardship Program, the Presidio Park Stewards, the Habitat Restoration Team, and the Invasive Plant Patrol – each having vegetation management responsibilities that are defined primarily by geographic ranges (subwatersheds and watersheds). Integrally linked to the field habitat restoration program is the park's Native Plant Nursery Program. The relationship and roles between these program elements varies from watershed to watershed and in scope of work. In some areas, Fort Funston for example, the nursery program and field restoration program elements are tightly woven, and are implemented by the same volunteer stewards. On the Presidio, the nursery and field program components have grown so significantly that their linkage is based upon strong relationships and shared responsibilities between individual program element managers — with volunteer stewards often having distinctly different responsibilities.

A detailed description of the planning and prioritization strategy for implementing habitat restoration projects at the park is found in Appendix A. This strategy includes program elements that plan, coordinate and implement the strategy through the park.

The Vegetation Stewardship Program coordinates habitat restoration activities in more than 2,500 acres of the park. Activities are located throughout the park, from Bolinas Ridge in the north, to Sweeney Ridge in the south, a distance of approximately 30 miles. The program conducts restoration projects in many habitat types including sand dunes, coastal bluffs, grasslands, coastal scrub, streams, coastal wetlands, oak woodlands, and redwood forest.

Habitat Restoration Team

The Habitat Restoration Team (HRT) is a drop-in community-based program that works throughout the park implementing restoration activities. It is facilitated by Natural Resource Management (NRM) and supported in part by the Golden Gate National Parks Association. The program coordinator prepares comprehensive management plans for each restoration region and/or project, and an annual plan that outlines the program's objectives and targeted activity locations within the 22 watersheds covered by HRT. Within each subwatershed and restoration site, the volunteers accomplish a variety of management activities such as removing invasive non-native plants, gathering propagules, revegetation, and monitoring. HRT works in 5 of the park's special ecological areas. HRT appeals to all age groups and backgrounds, and attracts approximately 20 to 30 people each workday (workdays are conducted once a week). Many HRT volunteers have participated in the program for more than 9 years, and contribute to the larger vegetation program's goals through their invaluable knowledge about the park's resources.

Site Stewardship Program

This program is facilitated and supported by the Golden Gate National Parks Association and overseen by NRM. Volunteers in the Site Stewardship Program (SSP) take responsibility for planning and implementing restoration and other natural resource management activities in their adopted watersheds.

There are currently three regions that have been adopted by Site Stewards: Oakwood Valley, Milagra Ridge and Wolfback Ridges. Site Stewards create comprehensive management plans for outlining proposed restoration activities, recruit and manage other volunteers to help, schedule activities, and supervise, document and monitor the work that is done in the park's Restoration Database. Site Stewardship Program volunteer recruitment targets local constituents who desire greater involvement with their environment and surrounding community, and are able to commit time and energy toward developing a program of their own. Additionally, the SSP has developed five long-term partnerships with local schools, universities and non-profit organizations to provide consistent community participation for priority restoration projects.

The Presidio Park Stewards

This program focuses its habitat restoration and resource education programs in GGNRA's urban center — the Presidio of San Francisco. The program's primary responsibility is for the stewardship of approximately 140 acres of rare or endangered plant habitat (supporting 12 special status species), which is expected to expand to approximately 430 acres (over approximately 50 years), upon the implementation of the Presidio's Vegetation Management Plan. Three of the park's special ecological areas are found within the 140 acres currently stewarded by the program. Volunteer recruitment for the program focuses primarily on the diverse constituents of San Francisco, local urban youth, and members of local environmentally based non-profit groups. The Presidio Park Stewards have also developed long-term partnerships with six local high schools, several universities, Americorps, and non-profit organizations to provide consistent community participation for priority restoration projects. Volunteers remove non-native plants, propagate native species, administer resource education programs, develop interpretive materials, monitor rare species, conduct literature searches, participate in research studies and use GIS and the park's restoration database. The program is managed by NRM.

With the transition of 80 percent of Presidio lands now under the management of the Presidio Trust, the Presidio Park Stewards are working to develop a common vision and an integrated approach to vegetation management throughout the Presidio. Much of this approach will be defined throughout the implementation strategy developed through the Vegetation Management Plan for the Presidio.

Crissy Field Stewardship

The Crissy Field Stewardship Program is linked directly to the larger Presidio program. Due to the size of the Crissy Field Project's vegetation restoration efforts (18 acres of marsh re-creation and 11 acres of dune re-creation), a temporary off-shoot program was developed. The program is responsible for coordinating the community stewardship participation and resource education program for the first 10 years of the project (3 years of construction and 7 years of maintenance), at which time the maintenance of the restoration efforts will be incorporated into the larger Presidio Park Stewardship Program. This program is piloting the integration of a 20-person Americorps program into park operations to achieve the project's restoration objectives and community development objectives. The program is currently funded by the Golden Gate National Parks Association and overseen by NRM, and will be funded by NRM beginning in 2001.

Big Events

The size and scope of the community work days varies for each program. Most programs integrate approximately 40 people on a daily basis. Several times a year, however, GGNRA hosts big events (drawing hundreds of volunteers) such as the celebration of Earth Day, National Service Week, San Francisco Conservation Corps' Serv-athon, and other corporate-sponsored events. The worksites are

chosen based on their ability to support large groups of people who accomplish a variety of tasks over a short span of time.

Other Groups

Many other groups plan and implement native plant restoration in the park. The park's Division of Maintenance has worked in cooperation with Natural Resource Management on several major trail obliteration and restoration projects. The California Department of Transportation and the Federal Highways Administration have implemented large-scale restoration projects that involve fill removal from wetlands and tunnel reconstruction, respectively. The Golden Gate Bridge District is currently restoring 18 acres of mission blue butterfly habitat at Fort Baker and Kirby Cove as a part of a mitigation requirement. In addition, private consultants and contractors, and local Conservation Corps are often hired to assist the park in accomplishing restoration objectives. Vegetation program staff serve as the park's liaisons for the majority of these projects, and provide technical expertise and oversight to each agency's project when required.

Resource Education (Curriculum and Non-Curriculum-Based)

All Vegetation Stewardship Program elements participate in a diversity and continuum of resource education activities. These activities range from creating brochures and slide presentations regarding vegetation management activities (i.e., invasive non-native tree removal in urban areas) to developing and implementing curriculum-based, restoration-focused programs for middle and high school students (this is done in partnership with the Division of Interpretation). Participation in the development and delivery of resource education materials has been critical to the success of many issue-based resource management projects. In 1998 the Division of Interpretation piloted the Center for Resource Interpretation concept; however, lack of funding prevented its continuation. This model meets the resource education needs of the Vegetation Stewardship Program, and without its continuation and expansion, staff will have to continue to develop materials with limited resources, and with little formal training and experience in public program delivery, graphic layout and design, or brochure development.

Funding has been secured to support the curriculum-based resource education programs. The following programs are being formally piloted under the funding received.

National Park Labs: Students, Stewards and Sustainability. In 1995 the Presidio Park Stewards developed the Presidio Stewardship Education Program, a curriculum-based program that enabled high school youth to participate in the ecological restoration cycle of activities through adopting a site on the Presidio. In 1997 the Site Stewardship Program piloted a stewardship-based curriculum on Milagra Ridge. In the spring of 1998, GGNRA received a 3-year grant from Toyota USA Foundation/National Park Foundation to enhance and closely link the Presidio Stewardship Education Program and the Milagra Ridge Stewardship Program with new curricula, a telecommunications network for high school stewards (Web page), teacher institutes, increased opportunities for service learning, paid high school internships and translations of the curriculum into Spanish and Chinese. The Milagra component, in partnership with Oceana High School, includes a native plant nursery, which will be managed by Oceana High School students.

Here's the Dirt: Science Education at the Native Plant Nursery. In January 1999, GGNRA received a 2-year grant from Exxon Foundation/National Park Foundation to introduce national science standards to middle school programs at the Presidio and Marin Headlands Native Plant Nurseries. The program will be developed in partnership with teachers. Following a pilot phase, the program will be adopted by the native plant nurseries at Fort Funston and Muir Woods.

Key habitat restoration and community stewardship projects currently underway include:

- Crissy Field Marsh and Dune System Revegetation
- Mission Blue Butterfly Habitat Restoration
- Lobos Creek Dunes Restoration
- Rare Plant Habitat Restoration

Project statements directly related to habitat restoration include:

GOGA-N-004.000 Mission Blue Butterfly Habitat Restoration — Thoroughwort Control
 GOGA-N-004.001 Mission Blue Butterfly Habitat Restoration — Marin Headlands
 GOGA-N-004.002 Mission Blue Butterfly Habitat Restoration — Milagra Ridge
 GOGA-N-004.003 Mission Blue Butterfly Habitat Restoration — Milagra Ridge (18 acres)
 GOGA-N-015.000 Restore and Manage GGNRA Grassland Habitats
 GOGA-N-021.000 Protect and Manage Bank Swallow Populations
 GOGA-N-033.000 Crissy Field — Community Stewardship
 GOGA-N-040.000 Protection of Unique Serpentine Bluff Features
 GOGA-N-042.000 Lobos Creek Restoration, Protection and Management
 GOGA-N-087.001 Habitat Restoration of Tennessee Valley ponds
 GOGA-N-087.002 Restoring Ecosystem Function to Valley Soils
 GOGA-N-091.000 Mountain Lake Management
 GOGA-N-098.000 Oakwood Valley Stream Corridor Alternative
 GOGA-N-180.000 Rodeo Lagoon Watershed Restoration

The Nursery Program

The park's native plant nursery program supports revegetation and community stewardship of the park's natural habitats. GGNRA's first native plant nursery was established 12 years ago at Fort Funston to fill a critical need for genetically appropriate native plant stock for use in the park's natural areas. Nurseries were then developed at Muir Woods, Tennessee Valley, Stinson Beach, the Presidio, Oceana High School and, most recently, at Fort Cronkhite. Because the nursery operations are dependent on local community support and involvement, distribution of the nurseries throughout the park allows volunteers to work in their own "backyards" on the entire range of restoration activities, both in the field and in the nursery. As a complement to growing and restoration activities, the nurseries offer educational programs that promote environmental awareness, understanding and stewardship in the youngest members of the community.

Presidio and Headlands Nursery are considered as the "major" nurseries, serving as centers of plant production within their respective districts. They have full-time staff, larger facilities and longer hours. The staff and facilities can support more extensive educational programs, allowing larger and more frequent visits by school and community groups. Like all the nurseries, the major nurseries rely on volunteer workers from their local communities. However, because of the emphasis on plant production at the major nurseries, volunteers spend more of their time propagating and tending plants than in the field doing restoration work.

"Satellite" nurseries serve a key role as centers for park restoration activities. Muir Woods, Tennessee Valley, Fort Funston and Oceana Nurseries have each built a strong constituency of local volunteers; park neighbors who want to learn about park stewardship by participating in all aspects of restoration work. Volunteers remove non-natives, collect seed, propagate plants, tend them and finally plant them on the site being restored. While these smaller nurseries have very modest facilities and lack room or staff to produce large numbers of plants, they are invaluable to the nursery system's mission of teaching and building community stewardship.

In 1997 steps were taken to organize the nurseries, then operating independently, into a more formalized nursery system capable of producing large numbers of healthy native plants for the growing number of park restoration projects. A full-time nursery specialist was hired by the Golden Gate National Parks Association to coordinate, streamline and professionalize nursery operations. The current nursery program propagates more than 120 different plant species, including the brackish and freshwater wetland species required for the restoration of the Crissy Field tidal marsh and dune system. Each nursery offers resource education programs and two offer active curriculum-based education programs for diverse urban youth.

The park's nurseries have a goal to supply all the native plants needed for the continued restoration of degraded habitat areas throughout the park, as well as any unique non-native plants needed for restoration of the park's cultural and historic landscapes by 2002. This is expected to require production of up to 140,000 healthy plants per year. The work of the nurseries will be accomplished through the participation of a committed and diverse volunteer workforce. Additionally, the nurseries will offer an active curriculum-based education program, helping to instill in the next generation a love of nature, an understanding of the importance of natural systems and the flora that comprise them, an understanding of genetic conservation, and a sense of stewardship for the park and its resources. The educational program will serve the Bay Area's culturally and ethnically diverse community, giving many more children the opportunity to know and contribute to the preservation and restoration of this unique and valuable resource.

Revegetation

Revegetation efforts are directly linked to both the nursery and habitat restoration components of the vegetation program. Current efforts are underway to evaluate a representative sample of the park's past restoration efforts. Revegetation efforts representing a wide range of GGNRA habitat types have been selected for analysis. Information gathered for each site includes site physical and biological site characteristics, restoration history, including all soil or weed control treatments, and planting lists. Each site was surveyed to count surviving plants and evaluate their condition. At the time of writing, most sites have been surveyed, and the data are being analyzed. The results from this study will be used to assess past success, and to guide future choices about site selection and plant propagation. Additionally, this monitoring format can be used to track the success of outplanting efforts in new sites or with plants that have been propagated with different timing or propagation techniques.

Key revegetation projects currently underway include:

- Crissy Field marsh and dune system revegetation

Project statements directly related to native plant nursery management include:

- GOGA-N-016.000 Management of Native Plant Nurseries — Program
- GOGA-N-016.001 Management of Native Plant Nurseries — Seed Collection Guidelines
- GOGA-N-016.002 Management of Native Plant Nurseries — Restoration of Adjacent Habitats

4.6.2 Invasive Non-Native Plant Management

The spread of non-native plants represents the most significant threat to the biodiversity of the park. The flora of the GGNRA is very rich, containing more than 48 vegetation plant community types (Keeler-Wolf et al. 1998). One or more of the park's 21 most invasive non-native pest plant species invade approximately 85 percent of these plant communities. Research on these invasive plants within the park has shown that their presence can alter community composition and reduce the diversity of native plants

(Alvarez and Cushman 1997), insects (Fisher 1997) and small mammals (Howell, pers. comm. 1997). Invasive non-native species are also found within all nine Special Ecological Areas designated as the most biologically intact and diverse areas within the GGNRA (NRMP 1994); habitat for the federally endangered mission blue and San Bruno elfin butterflies, Raven's manzanita, Presidio clarkia, San Francisco lessingia, as well as 12 other special status plants (listed by the state and the California Native Plant Society).

The existing park flora includes 886 vascular plant species and subspecies. Approximately 40 percent of the flora consist of non-native plants. A relatively small number of these non-native species are considered major threats. Control, containment and removal of invasive non-native plants are major components of the vegetation program. These efforts have resulted in the increase of species richness in once-impacted habitat, the improvement of wildlife habitat value, the conservation of rare plant and animal species, and the improvement of water quality. To date, control strategies have proven feasible for 12 pest species (*Genista monspessulana*, *Cytisus striatus*, *Cytisus scoparius*, *Delawarea odorata*, *Leucanthemom vulgare*, *Cortaderia jubata*, *Centaurea solstitialis*, *Vinca major*, *Ulex europaeus*, *Arctotheca calendula*, *Hedera helix*, *Zantedeschia aethiopica*). These invasive plant populations are considered under control due to a decade of volunteer, staff and grant expenditures. And despite the extensive urban perimeter around the park, only two new invasive species have established small populations within the park within the last decade.

The remaining priority invasive non-native plant species (10 of the 21) have been targeted for control based upon their significant rate of spread, parkwide occurrence, formation of dense low diversity stands and feasibility of ongoing reduction and control. These species include: Monterey pine (*Pinus radiata*), eucalyptus (*Eucalyptus globulus*), Monterey cypress (*Cupressus macrocarpa*), black acacia (*Acacia melanoxylon*), thoroughwort (*Ageratina adenophora*), cotoneaster (*Cotoneaster* sp.), helichrysum (*Helichrysum petiolare*), Himalayan blackberry (*Rubus discolor*), tall fescue (*Festuca arundinacea*) and harding grass (*Phalaris aquatica*).

The strategy for controlling invasive non-native plant species in the park has evolved throughout the past ten years. The step-by-step approach to managing invasive non-native species is found in Appendix B. The effectiveness of the park's ability to implement each component is being and/or will be evaluated during the next two years.

Project statements directly related to invasive non-native species data collection and management include:

- GOGA-N-001.001 Control of Exotic Plant Species — Program
- GOGA-N-001.002 Control of Exotic Plant Species — Thoroughwort Containment
- GOGA-N-001.003 Control of Exotic Plant Species — Bellardia Containment
- GOGA-N-001.004 Control of Exotic Plant Species — Pampas Grass Containment
- GOGA-N-001.005 Control of Exotic Plant Species — Cotoneaster Containment
- GOGA-N-001.006 Control of Exotic Plant Species — Cape Ivy Management
- GOGA-N-001.007 Control of Exotic Plant Species — Eucalyptus Grove Perimeter Containment
- GOGA-N-001.008 Control of Exotic Plant Species — Eucalyptus Pilot Removal Project
- GOGA-N-001.009 Control of Exotic Plant Species — Eucalyptus Grove Removal
- GOGA-N-001.010 Control of Exotic Plant Species — Mattress Vine Containment
- GOGA-N-001.011 Control of Exotic Plant Species — Ox-Eye Daisy Containment
- GOGA-N-001.012 Control of Exotic Plant Species — Monterey Pine/Cypress Perimeter Containment
- GOGA-N-001.014 Control of Exotic Plant Species — Monterey Pine/Cypress Removal
- GOGA-N-001.015 Control of Exotic Plant Species — French Broom
- GOGA-N-001.016 Control of Exotic Plant Species — Backlogged Bolinas/Coyote Ridge

- GOGA-N-001.017 Control of Exotic Plant Species — Cyclic Maintenance
- GOGA-N-001.018 Control of Exotic Plant Species — Containment of Exotic Woody Shrubs and Trees
- GOGA-N-001.019 Control of Exotic Plant Species — Mapping Target Exotic Species
- GOGA-N-001.020 Control of Exotic Plant Species — Harding Grass/Tall Fescue Containment
- GOGA-N-004.000 Mission Blue Butterfly Habitat Restoration — Thoroughwort Control
- GOGA-N-087.002 Restoring Ecosystem Function to Valley Soils

4.6.3 Rare Plant Management

Within GGNRA, 38 rare or special status species are currently identified. Of those species, 9 are federally endangered, 1 is federally threatened, 13 are federal species of concern, and the remaining 15 species are included or proposed for inclusion by the California Native Plant Society. GGNRA has adopted the policy that all special status plant species be afforded the full protection of the Endangered Species Act. The Superintendent may judge on a case-by-case basis that the evidence against the listing of a particular plant species is sufficient to allow a specific action. One of these species, the Raven's manzanita (*Arctostaphylos hookeri* ssp. *ravenii*), has a limited population of only one "wild" plant, with numerous clones that have been outplanted under direction of its recovery plan. This species occurs nowhere else in the world. The largest or majority of several of these species populations are found within the park (e.g., Presidio clarkia, San Francisco lessingia, Crystal Springs lessingia, San Mateo thornmint, fountain thistle, San Mateo wooly sunflower, and white-rayed pentachaeta). Many of the park's listed species occur in small numbers in only a few populations. Because the park provides one of the last refuges for many of these plants, it is critical that the remaining populations be protected and encouraged to expand.

For the past five years the primary focus of the park's rare plant program has been on the 12 special status species found on the Presidio. Staff and volunteers, working in partnership with local universities and community organizations, have monitored the range and size of each species populations, developed restoration and monitoring objectives for 70 percent of the species, controlled or removed the most significant invasive species threats for all 12 species, tripled the available habitat for both the federally listed San Francisco lessingia and Presidio clarkia through restoration efforts, increased the population of lessingia 100-fold, and presented public education and high school curriculum programs to increase public awareness, increase stewardship, and develop advocacy for the parks rare plant program.

The step-by-step approach to rare plant management in the GGNRA is found in Appendix C.

The strategy for managing rare plants in the GGNRA has been outlined in the following project statements:

- GOGA-N-007.004 Vegetation Inventory and Monitoring — Rare Plant Protocol Development
- GOGA-N-009.000 Rare Plant Management — Program
- GOGA-N-009.001 Rare Plant Management — Raven's Manzanita Recovery Plan
- GOGA-N-009.002 Rare Plant Management — Franciscan Thistle Management
- GOGA-N-009.003 Rare Plant Management — Presidio Clarkia Management
- GOGA-N-009.004 Rare Plant Management — Reintroduction of Rare Dune Species
- GOGA-N-009.005 Rare Plant Management — Grazing Effects on Nicasio Ridge
- GOGA-N-009.006 Rare Plant Management — Reintroduction of San Francisco Owl's Clover
- GOGA-N-009.007 Rare Plant Management — Parkwide Plan Development/Implementation

4.6.4 Vegetation Inventory and Monitoring

Inventory and monitoring activities are necessary to collect information about the structure, function, condition and trend of the plant populations and communities within the park. The objectives of GGNRA's current Vegetation Monitoring Program are implemented by the larger field habitat restoration and community programs staff. Approximately 70 percent of the monitoring efforts are directed toward tracking the effectiveness of restoration management activities. The remaining 30 percent have focussed on the parkwide vegetation communities classification project and rare plant census. Additional resources are required to implement a more holistic vegetation monitoring program, which will include elements listed under the GGNRA and Point Reyes Inventory and Monitoring Plan section.

A synthesis of the existing vegetation monitoring program components and protocols (all are limited in application due to limited resources) is found in Appendix D.

Currently the park is compiling a joint Inventory and Monitoring Plan with Point Reyes. The vegetation monitoring program elements identified under this plan significantly expand the park's existing vegetation monitoring efforts to include landscape, community and population monitoring for all of the park's terrestrial ecosystems. At the population level, the criteria for selection of plants is classified into non-native plants, rare and endemic plants, pollution sensitive plants, and animal plant relationships. Efforts are underway to define the monitoring objectives, protocols, sampling design and data analysis for each of these categories, as well as fund the plan's implementation.

Project statements directly related to vegetation inventory and monitoring include:

- GOGA-N-007.000 Vegetation Inventory Monitoring — Program
- GOGA-N-007.001 Vegetation Inventory Monitoring — Vegetation Inventory
- GOGA-N-007.002 Vegetation Inventory Monitoring — Host Protocol
- GOGA-N-007.003 Vegetation Inventory Monitoring — Arthropod Inventory
- GOGA-N-007.004 Vegetation Inventory Monitoring — Rare Plant Protocol Development
- GOGA-N-007.005 Vegetation Inventory Monitoring — Exotic Species Inventory/Monitoring
- GOGA-N-007.006 Vegetation Inventory Monitoring — Floral Inventory
- GOGA-N-033.001 Crissy Field — Restoration Monitoring

The implementation of the vegetation monitoring program incorporates many long-term stewards, volunteers, interns, graduate students and schoolchildren, where feasible. This support has been critical both due to lack of federal funds, and to ensure that general public has a stake in the ecological health of the park's natural resources. Data collection and analysis needs to be coordinated by staff to ensure consistency, continuity and quality.

4.6.5 Sustainable Vegetation Waste Practices

A sustainable vegetation disposal program for waste material and forest products generated during tree hazard mitigation and other forest management activities is needed to ensure that organic debris is not disposed of in an unsustainable manner, that administrative needs for forest products for construction, restoration, interpretation, or other needs are met, and that valuable forest products are not disposed of without recovering their fair market value. The Green Maintenance movement that is gaining momentum at the park may generate and would support sustainable practices for dealing with forest products and byproducts, including sawlogs, firewood, chips and seeds.

The program will be developed jointly with other interested divisions in the park.

4.6.6 Information Management

GGNRA stores all its habitat restoration data for more than 140 project sites/subwatershed regions; vegetation and rare plant monitoring data; floral inventory; and native plant nursery program data within a parkwide restoration database. This database contains more than 25 separate databases containing more than 5,000 records, and is organized by watershed. The database is networked throughout the park using the CITRIX software platform. GGNRA vegetation staff and volunteers are also creating GIS layers of rare plant populations, restoration site locations, invasive species populations, watershed and subwatershed boundaries, vegetation plant communities and sensitive habitat areas. Efforts are underway to link both systems to provide a more effective and time efficient means to conduct planning efforts, and evaluate threats and values to natural systems. The database is presently run using Microsoft Access 2.0, and a database program designed two years ago for Windows 3.0. The most recent version of this database software is Access 97, designed for Windows 95. The GIS program uses ArcView 3.1.

Project statements directly related to information management include:

- GOGA-N-014.000 Geographic Information System
- GOGA-N-014.001 Geographic Information System — Vegetation Information Management Program
- GOGA-N-014.002 Geographic Information System — Linking ArcView to Restoration Database

4.7 Forestry Program

The Forestry Program has three emphases: the interactions between natural resources and human history (cultural landscape management), the natural forest management of the park and hazard tree management. The program encompasses the trees and open spaces that frame signature vistas, constitute the habitats of plant and animal communities, and set the scene for historic landmarks.

Some park forests were purposefully designed and created using nonindigenous species. Most have evolved as the result of biotic and abiotic factors that have been markedly changed by post-Columbian residents.

To accomplish this program, a professional forester is needed. The forester will be familiar with natural resources management in the NPS and be able to interact with park staff, cooperators, contractors, and the public. Contractors will be employed to inventory forest resources and develop forest management plans, remove designated trees, prepare sites for restoration, and plant appropriate vegetation. Interns will assist in developing site plans, manage volunteer work groups, and inventory and monitor forest parameters. People working through the Volunteers-In-Parks program will collect, treat, and plant seeds and other plant materials, operate nurseries, plant seedlings, and maintain plantings.

Support from other park division includes development and delivery of educational and informational materials and programs for park users and park neighbors, consultation and specialized equipment assistance, and assistance in securing equitable service contracts and recovering fair market value of natural products generated as a by-product of forest management.

Forestry is a new program at GGNRA and project statements will be developed that identify the issues, problems, activities, and compliance associated with the program. These projects will be developed during 1995; preliminary projects are listed below.

4.7.1 Inventory Natural Forest Resources

Most of the lands within the park have high natural and cultural resource values. Many of these high values are only known qualitatively and have not been inventoried or documented. Forested areas that likely contain the natural resource values most sensitive to impacts and needing quantification are: Phleger Estate, San Francisco Watershed Lands, Lobos Creek Drainage, El Polin Springs, Muir Woods, Oakwood Valley, Bolinas Ridge, and Lagunitas Creek Drainage.

Inventories are necessary to properly manage these natural forest resources. Information such as vegetative species composition, age and size distribution, special status species presence, use patterns and needs, stand vigor and population dynamics, fuel loading, socio-political management pressures, and threats to natural functioning of forest ecosystems will be collected. Smaller areas can be inventoried on the ground, but larger areas will require remote sensing techniques and use of models, with sampling and ground truthing field work.

These projects can be accomplished by contracts if funding is available, or done by GGNRA staff more slowly. Projects statements will be written and funding sources explored.

4.7.2 Control Non-Native Forest Encroachment into Natural Habitats

Non-native forests have expanded into sensitive native habitats, decreasing park bio-diversity. The plantings of non-native Monterey pine, bluegum, eucalyptus, Monterey cypress, and other tree and shrub species have caused the changes in the microclimate and development in a way that favors non-native plants.

Natural communities threatened by non-native trees will be protected by implementing the following strategy: determine location of invasive trees; determine rates of expansion into the adjacent natural habitats; identify control priorities; evaluate alternative control methods and costs; and implement the most effective control actions.

Areas where forest encroachment on sensitive non-forest habitats is suspected to be a problem include: Milagra Ridge, Lands End, Presidio of San Francisco, Marin Headlands, Mount Tamalpais, Olema Valley. Project statements will be written for these projects. Mapping of these areas can occur by contract or by the park forester. Implementation can be contracted and overseen by park natural resource staff.

4.7.3 Historic Landscape Tree Inventory and Management

Many historic areas of the park were landscaped long ago with trees and other vegetation that have either matured or become senescent and died, fallen down, or been removed.

Different levels of management can occur on these landscapes, but identification and documentation of existing and missing tree components of these landscapes is a basic need. After these landscapes are identified and documented and missing components are characterized. Treatments for preservation, rehabilitation, restoration, and reconstruction all include replacement of identified missing tree components of historic landscapes.

Areas where tree components of historic landscapes are missing include: Fort Funston, Fort Miley, Sutro Heights, Fort Mason, The Presidio of San Francisco, Fort Baker, Fort Cronkhite, Fort Barry, and Olema Valley Ranches. Project statements will be developed and these areas researched using volunteers and interns.

4.7.4 Heritage Landmark Trees Management

Many trees identified during an inventory of historic landscape trees may qualify as Heritage Landmark Trees. Other trees will have to be identified through additional surveys. These trees are threatened by past management practices and possible neglect. They need to be identified and treatment strategies recommended.

A project statement will be written in coordination with cultural resources staff and park landscape architects.

4.7.5 Clarify Forestry Standard Operational Procedures

Standard Operating Procedures (SOP) were completed in 1995 to document physiological, cultural, managerial, and legal directions and limited to vegetation cutting and removal.

Training Sessions will communicate changing arboricultural principles and practices to new and incumbent employees with vegetation cutting responsibilities. Subscriptions to and careful review of professional journals and trade magazines, and participation in training sessions and professional societies are required to keep informed on evolving arboricultural practices. Information gleaned from these publications and meetings will be passed along to appropriate supervisors and employees practicing these skills in the field.

4.7.6 Hazard Tree Management

Hazardous tree conditions exist when a defective tree and a target threatened by that tree defect coexist. The expansion, maturation, and decadence of forests throughout GGNRA lands, due to abiotic factors such as drought and erosion, have adversely affected tree health. This increased in hazard, together with increased visitation and management activity necessitates a comprehensive inventory of hazardous trees in developed areas.

A hazardous tree survey has been completed on the Presidio. Other parts of the park that have trees and targets have not been systematically surveyed. A project statement will be written for a comprehensive survey and treatment recommendations of hazardous tree conditions.

Trees identified as hazardous will be treated by a well-staffed, well-trained, and well-equipped work force. Treatments will include closure of high-hazard areas until hazards are mitigated, physical treatment of hazardous tree defects, and restoration of work sites.

4.8 Range Inventory and Management

Many of the vernacular landscapes of the park evolved with intensive grazing pressures from native ungulates, and later, grazing by domestic stock. Current stock use on lands managed by GGNRA other than equestrian trail use is mostly limited to horse stables and boarding operations. The northern lands, administered by Point Reyes National Seashore, have extensive areas grazed by cattle.

Stock impacts include competition with native animals due to space occupancy and utilization of range herbs and forbs, increased bare exposed soil and physical damage to soil structures, physical damage to riparian corridors and wetlands, compaction of soils resulting in reduced precipitation infiltration and increased runoff and erosion, introduction and spread of non-native plants through feed and bedding straw, and increased nutrient loads in runoff due to feces and urine from stock.

These impacts have been observed at the park, and while it is commonly agreed among natural resource managers that these ranges are often being overutilized, carrying capacities and rest/rotation periods cannot be determined until range conditions, primary production, and utilization are quantified.

Preparation of Ranch Unit Plans will document existing conditions and outline management activities, to ensure that domestic range uses are compatible with General Management Plan objectives. Non-trail stock use occurs in Olema Valley and Bolinas Ridge. These projects are in the northern lands administrated by Point Reyes National Seashore. Equestrian stables in the rest of the park will be evaluated by park staff, and management actions developed and written into permits.

4.9 Prescribed Fire Management

The Golden Gate Fire Management Plan is an addendum to the Natural Resource Management Plan. Prescribed burns are monitored before, during, and after burning according to strict Western Region prescribed fire guidelines. The fire management office monitors burn sites and does not have adequate personnel to meet regional guideline requirements and to monitor additional site-specific elements that may be desirable for answering questions about ecological fire effects that natural resource managers may pose.

Several changes in the vegetative mosaic at the park have occurred due to the suppression of fires. Fire suppression changed the physical processes that shaped the landscape and reduced the area of plant communities that are adapted to fire. This action also increased the areas of plant communities that are fire sensitive. The park therefore has an encroachment of fire sensitive trees, such as Douglas fir, into fire-adapted communities such as chaparral. This is reducing the biodiversity of the park. Fire can be used, in a prescribed manner, to revitalize fire-adapted communities and reduce the encroachment of fire-sensitive trees.

Additional site data on fire effects could assist in resolving natural resource concerns. The fire management office and the natural resource staff will work together to identify additional data gathering opportunities that would likely result in a favorable information/effort ratio. The Golden Gate Fire Management office had a five-year burn plan that ran through 1997. Opportunities are available for suggesting future burn locations, prescriptions, and monitoring of fire effects for inclusion in the future plan.

Natural resources staff reviews the Fire Management Plan and each individual Burn Unit Plan to ensure all natural resource issues have been taken into account. Natural resource staff also participates in planning and implementing the fires. The Fire Management office has the responsibility for writing the Fire Management Plan and implementing the program.

4.10 Aquatic/Hydrology Program

The aquatic/hydrology program focuses on four core areas: inventory and monitoring, aquatic habitat and species protection, aquatic habitat and species restoration, and data management and dissemination.

Outside of the NPS structure, several local, community organizations emphasize fish and habitat protection and restoration as their main goals (e.g., Stream Matrix, Urban Watershed Project, San Francisquito CRMP/Streamkeeper). All groups are working with the park to ensure the well-being of fish and habitat within park boundaries as well as outside. Critical needs identified by these groups include access to equipment for restoration and monitoring and training opportunities in restoration and monitoring. A key focus of the park's aquatic/hydrology program will be to support community-initiated

protection and restoration activities when possible in park areas by providing technical assistance and by addressing critical needs.

The following is an overview of the eight core areas that comprise the aquatic/hydrology program.

4.10.1 Inventory and Monitoring

Inventory and monitoring activities are necessary to detect or predict changes that may require intervention, and to serve as reference points for more altered parts of the environment. Currently, the park is putting together an inventory and monitoring plan in conjunction with Point Reyes National Seashore, The Presidio, and Muir Woods National Monument. For aquatic habitats, the plan is divided into marine, freshwater, and transition ecosystems. Selected biological elements to monitor include the following:

1. Sensitive aquatic wildlife species
2. Indicator species and items (chosen species and items must be sensitive to changes in the environment and management)
3. Trophic level indicator species (primary producer, primary consumer, and top level predator)
4. Non-native species

To track the health of these aquatic habitats, physical and hydrologic processes need to be inventoried and monitored as well. The inventory and monitoring plan proposes the following:

1. Topographic monitoring of wetland and aquatic sites
2. Mapping and assessment of wetland and aquatic sites
3. Streamflow monitoring
4. Wetland inventory
5. Sources and quantity of water use
6. Watershed land use
7. Groundwater monitoring
8. Water quality monitoring

Currently 8 aquatic/marine wildlife species that reside within the park are federally listed as threatened or endangered. An additional 6 aquatic/marine federal species of concern and 1 aquatic/marine California species of special concern also reside in the park.

The current biological inventory and monitoring program focuses on sensitive aquatic wildlife species. For coho salmon and steelhead trout, spawner and redd surveys are being conducted during the winter. Distribution and abundance of juvenile salmonids are conducted on a few streams using snorkel and electrofishing techniques. The tidewater goby is monitored annually in Rodeo Lagoon during the late fall. Winter monitoring of red-legged frog breeding activities using calling, egg mass, and adult surveys are being conducted at several potential breeding sites within the park. Inventories for the California freshwater shrimp are being conducted and the GGNRA has cooperated with the Marin Municipal Water District in their shrimp monitoring program.

Future biological monitoring would expand to include the other three biological elements: indicator species and items, trophic level indicator species, and non-native species. Inventory actions would be prioritized so that data gaps (e.g., freshwater and marine invertebrates) can be filled.

A flexible organizational structure will best accomplish these actions. Because of permitting issues, inventory and monitoring of threatened or endangered species will come under the guidance of the park aquatic ecologist. Because biological inventories are relatively short term and can often require specialized taxonomic skills, we expect to develop and use cooperative agreements with local universities, resource management agencies and research institutions to conduct inventories. Monitoring of physical and hydrologic properties and maintenance of databases would be assisted by Biological and Physical Science technicians.

Related inventory and monitoring project statements are as follows:

- GOGA-N-010.000 Research and Write Protection Plan for San Francisco Garter Snake
- GOGA-N-019.000 Tidewater Goby Monitoring
- GOGA-N-020.000 Inventory Marine and Estuarine Resources
- GOGA-N-022.000 Protect, Inventory, and Monitor California Freshwater Shrimp
- GOGA-N-023.000 Rare Insect Survey
- GOGA-N-025.000 Monitor Marine and Estuarine Resources
- GOGA-N-025.001 Monitor Marine and Estuarine Resources — Vegetation
- GOGA-N-029.000 Inventory and Monitor Aquatic Resources
- GOGA-N-029.001 Inventory and Monitor Aquatic Resources — Amphibians
- GOGA-N-029.002 Inventory and Monitor Aquatic Resources — Bivalves
- GOGA-N-033.001 Crissy Field — Restoration Monitoring
- GOGA-N-046.000 Research Marine and Estuarine Resources
- GOGA-N-065.001 Wetland and Aquatic Habitat Inventory
- GOGA-N-066.000 Investigation of Poor Water Quality in Rodeo Lagoon
- GOGA-N-081.000 Coho Salmon and Steelhead Preservation/Restoration Project
- GOGA-N-087.000 Management of Introduced Freshwater Animals

4.10.2 Habitat and Species Protection

Protecting wetland and aquatic habitats and the associated wildlife is the goal of this program. Currently, this includes review of internal and external planning documents, participation in National Environmental Policy Act compliance activities, coordination with resource agencies, providing technical assistance to park staff to mitigate potential impacts, participating in community-initiated protection actions, and developing educational materials for resource protection.

The plan for habitat protection focuses on identifying the types and extent of wetland and aquatic sites (per the classification system of Cowardin et al. [1979]). An important component of the plan is describing the functions and values of the existing wetland and aquatic sites. Much of this information is being obtained from inventory and monitoring activities for sensitive aquatic species. Specific details on wetland planning and protection are listed below in the project summary section.

Species protection largely depends upon the ability to protect habitat for aquatic organisms. Because many aquatic organisms move between park areas and areas under different land management, substantial time will be spent to coordinate resource protection at the watershed scale.

Included in this core area is protection of water quality and quantity — for the intrinsic values of water itself and for the benefits that natural stream flow and water quality provide for aquatic life. Specific details on water quality and quantity are also provided in detail below.

The means to accomplish habitat and species protection will be diverse. For park activities that may affect listed species or critical habitat, Section 7 Endangered Species Act consultations will be initiated. For

routine maintenance activities, programmatic Section 7 consultations will be sought. The park's aquatic ecologist and planning/compliance specialist will be responsible for working with other divisions within the park on Endangered Species Act issues. The park's Hydrologist and Physical Science Technician (proposed) will work with Division of Maintenance on erosion issues (see Physical Resources Program, below). To ensure protection of park aquatic resources from external threats, a Stay-in-School position is proposed to interface with Public Affairs and Interpretation on developing public outreach information.

Protecting habitats from external threats depends on strengthening partnerships established with community organizations. Provision of technical services, training activities, and access to Park resources (e.g., hand tools, monitoring equipment) will facilitate protection of aquatic resources. To ensure long-term continuity, the park aquatic ecologist and hydrologist will remain as the key contacts with these community organizations.

The following projects include protection of aquatic habitats that will occur within the next five years:

- GOGA-N-022.000 Protect, Inventory, and Monitor California Freshwater Shrimp
- GOGA-N-024.000 Range Management
- GOGA-N-028.000 Manage Marine Resources
- GOGA-N-037.000 Protect and Restore Anadromous Fish in Bolinas
- GOGA-N-038.000 Develop Riparian Zone Management Guidelines
- GOGA-N-040.000 Protection of Unique Serpentine Bluff Features
- GOGA-N-042.000 Lobos Creek Restoration, Protection and Management Plan
- GOGA-N-048.001 Development and Assessment of Stables Management Practices
- GOGA-N-064.000 Physical Resources Monitoring and Protection
- GOGA-N-081.000 Coho Salmon and Steelhead Preservation/Restoration
- GOGA-N-087.000 Management of Introduced Freshwater Animals
- GOGA-N-101.000 Protect and Restore Freshwater Aquatic Resources

4.10.3 Habitat and Species Restoration

The development of natural areas occurred within park boundaries prior to the establishment of GGNRA. A sizable amount of the park's historic wetland and aquatic sites has been altered. Currently, two major wetland and aquatic restoration projects, Crissy Field and Mountain Lake, are being planned and implemented. Director's Order 77-1 requires the park to identify, where possible, areas where existing facilities have impacted historic wetland and aquatic sites. The intent is to provide a starting point for identifying areas where restoration actions are possible.

The GGNRA program for aquatic habitat restoration will: 1) Use the historic record (e.g., old photos, maps, and text) and/or site potential to provide a general picture of the state of aquatic resources prior to extensive human manipulation, 2) Assess feasibility of restoration actions given costs and benefits, 3) Prioritize restoration actions, 4) Participate in planning for high priority restoration projects, and 5) Implement and monitor actions.

Collection of data to identify existing facilities that impair wetland and aquatic resources will include mapping of historic wetland and aquatic features from old maps, aerial photos, and field surveys. Identification of aquatic species and historic habitat conditions will be obtained from searching museum specimens, scientific literature, oral history, and pictorial data.

Currently, planning and implementation of large aquatic habitat restoration projects are being conducted largely by outside consultants with project management by park staff and/or personnel from the Golden Gate National Parks Association. Because of the long list of potential freshwater and estuarine restoration

projects, emphasis will be placed on developing restoration skills with current park staff and by developing long-term relationships with non-profit organizations, universities or resource agencies to ensure that restoration designs meet park goals and objectives at reasonable costs.

High-priority restoration projects are typically tied to those projects that yield sustainable results and produce benefits, direct or indirect, for listed species or species of concern. The aquatic restoration-related project statements are listed below:

GOGA-N-005.000 Redwood Creek Watershed Restoration Project
 GOGA-N-033.002 Crissy Field–Tennessee Hollow Plan
 GOGA-N-037.000 Protect and Restore Anadromous Fish in Bolinas Lagoon Tributaries
 GOGA-N-042.000 Lobos Creek Restoration, Protection and Management Plan
 GOGA-N-067.000 Design and Implementation of Aquatic Restoration
 GOGA-N-081.000 Coho Salmon and Steelhead Preservation/Restoration Project
 GOGA-N-087.001 Habitat Restoration of Tennessee Valley Ponds
 GOGA-N-091.000 Mountain Lake Management
 GOGA-N-098.000 Oakwood Valley Stream Corridor Rehabilitation
 GOGA-N-101.000 Protect and Restore Freshwater Aquatic Resources
 GOGA-N-101.001 Lower Wilkins Gulch Floodplain Wetland Restoration
 GOGA-N-180.000 Rodeo Lagoon Watershed Restoration
 GOGA-N-065.001 Wetland and Aquatic Habitat Inventory

The following project summaries span protection and restoration boundaries and are treated in their entirety below.

4.10.4 Watershed Management

The general philosophy is to approach these areas with a comprehensive watershed management. Where appropriate, watershed management plans will be written. Recommendations for watershed improvement projects will be guided by legislation such as the Clean Water Act, the Wetland Protection Executive Order-11990, NEPA, and other applicable guidance. Brief overviews of some of our watershed management areas are included under the “long-term, multifaceted projects” section of this document.

NPS policies encourage watershed management. Specifically, NPS-77 directs parks to develop water resources management plans that will support decision-making processes related to protection, conservation, use, and management of a park’s water resources.

Current threats to GGNRA’s watersheds (lakes and streams) include but are not limited to: sedimentation, toxic contamination, eutrophication, habitat fragmentation, urbanization, non-native plant invasion, cumulative impacts, and negative impacts due to internal park activities (bridges, roadways, building projects, grazing, visitor use).

Future watershed planning and restoration projects will address issues such as habitat fragmentation, migration corridors and barriers, bioregions (Point Reyes, State Parks, Watershed land coordination), cumulative effects of many small projects, and improvement natural biodiversity. A special emphasis will be put on promoting an interdisciplinary approach. The Mountain Lake Restoration Plan will be a future priority since it is the only natural lake managed by GGNRA.

Project statements that relate directly to watershed management include:

GOGA-N-042.000 Lobos Creek Restoration

GOGA-N-091.000	Mountain Lake Restoration, Protection and Management
GOGA-N-033.002	Tennessee Hollow Riparian Restoration
GOGA-N-180.000	Rodeo Lagoon Watershed Restoration
GOGA-N-005.000	Redwood Creek Watershed Restoration
GOGA-N-O	Lagunitas Creek Planning
GOGA-N-038.000	Develop Riparian Zone Management Guidelines
GOGA-N-024.000	Range Management
GOGA-N-048	Locate Sources of Contaminants
GOGA-N-039	Habitat Fragmentation
GOGA-N-036	Document Historic Trends in Ecosystems
GOGA-N-041	Manage Olema Valley/Creek
GOGA-N-087.001	Habitat Restoration of Tennessee Valley Ponds
GOGA-N-073	Coho Salmon/Steelhead Trout Preservation
GOGA-N-001	Control of Alien Plant Species
GOGA-N-002	Survey and Mitigate Erosion
GOGA-N-098.000	Oakwood Valley Stream Corridor Rehabilitation
GOGA-N-066.000	Investigation of Poor Water Quality in Rodeo Lagoon
GOGA-N-048.001	Stables Management Practices
GOGA-N-038.000	Develop Riparian Zone Management Guidelines

4.10.5 Wetland System Restoration and Protection

Wetland systems are among the most productive and threatened habitats in the park. Many of these habitats have been lost, while others are threatened by water diversions, sedimentation, agricultural uses, fragmentation, urban development, and water contamination. The Clean Water Act and NPS policy mandates “no net loss of wetlands” as defined by both acreage and function. Parks are also required to restore wetland function where it has been harmed by previous human actions (Guidelines for Natural Resource Management in the National Park Service, NPS-77).

The GGNRA program for wetlands protection and restoration includes: 1) identification of all wetland resources, 2) avoidance of actions that adversely impact wetlands, and 3) restoration and enhancement of wetland values wherever possible. All waters that flow into wetlands are similarly protected and the highest possible water quality standards will be met in these upstream waters.

Wetland protection and enhancement projects are proposed at Big Lagoon (Redwood Creek drainage), Rodeo Lagoon, and Crissy Field. Future projects may include Giacomini Ranch, Bolinas Lagoon, Tennessee Valley, and Eskoot Creek. At these sites, water quality will be monitored, wetland profiles and hydrologic function will be restored, sediment sources will be identified and mitigated, and aquatic resources will be enhanced. Wetland interpretation and education will also be improved by developing in-park wetland training, visitor information, and signing of sensitive habitats.

Project statements directly related to wetland restoration and protection include:

GOGA-N-048.000	Water Quality Monitoring Program
GOGA-N-012	Big Lagoon Restoration
GOGA-N-180.000	Rodeo Lagoon Restoration
GOGA-N-033	Restore Wetlands at Crissy Field
GOGA-N-020.000	Inventory and Monitor Aquatic Resources
GOGA-N-067	Compile Natural Resource Information
GOGA-N-002.000	Survey and Mitigate Erosion
GOGA-N-065.001	Wetland and Aquatic Habitat Inventory

Contracts can be let for the planning efforts. The programs will be complicated and will need special funding for implementation of each particular component.

4.10.6 Protection and Restoration of Water Quality and Quantity

Numerous water quality and quantity issues have been identified at GGNRA. These threats include surface water diversion, groundwater/aquifer depletion, water contamination (e.g., urban runoff, sewage, agricultural nonpoint source pollution, toxic materials including pesticides and herbicides, and sedimentation), and changes in physico-chemical factors such as pH, temperature, dissolved oxygen, and turbidity.

Water quality and quantity (proper hydrologic regimes) are the primary factors governing the health of our aquatic systems. Lakes, springs, streams, wetlands, and oceans are fundamentally linked to all other natural resource systems within the park. Plants and animals depend on water. Most of the park's endangered species are dependent on aquatic systems during some portion of their life. Water resources also provide recreation and inspiration to park visitors.

Strategies for protecting and improving water quality include water quality monitoring and management; establishing special protection zones within watersheds; identifying non-point source pollution; developing sustainable stables management practices; providing educational and interpretive programs focusing on watershed themes, conducting beach cleanup programs; and reducing the potential for pollution of aquatic systems. Enforcement will also be strengthened according to the guidance provided by State and Federal Clean Water programs.

Strategies for maintaining adequate flows and protecting natural hydrologic regimes include inventorying water rights, protecting groundwater, removing diversion structures, water conservation, and enforcing water rights. Working with local communities regarding water issues is important to successfully protect instream flows for aquatic life.

Project statements directly related to protecting and enhancing water quality and quantity include:

GOGA-N-037.000	Protect and Restore Andromous Fish in Bolinas Lagoon Tributaries
GOGA-N-048.000	Establish Water Quality Monitoring Program
GOGA-N-027	Inventory Water Rights
GOGA-N-038.000	Develop Riparian Zone Management Guidelines
GOGA-N-005.000	Redwood Creek Watershed Planning
GOGA-N-002.000	Survey and Mitigate Erosion
GOGA-N-065.000	Develop Water Resources Atlas
GOGA-N-024.000	Range Management
GOGA-N-028.000	Manage Marine Resources

4.10.7 Water Conservation, Recycling, and Sustainable Use

The water resources projects under this heading are part of the larger interdisciplinary program. They are in the spirit of the NPS's publication *Guiding Principles of Sustainable Design*. The goal of projects under this category is to create within GGNRA a model of environmental sustainability.

Threats associated with not developing this program include lowered water tables, water supply shortages, water quality degradation, and extinction of plants and animals.

Strategies for addressing these threats are all based on reducing consumption. Specific water conservation strategies include using low-flow toilets (toilets are the largest household water use), developing efficient irrigation systems, using drought tolerant landscaping, hooking up to reclaimed water systems, identifying

leaks in piping, and educating water users. Another strategy is to develop demonstration areas at locations such as the Presidio Golf Course, Muir Beach, and Fort Mason. Tenants and other park partners should be required to comply with this program.

Project statements that address this program include:

GOGA-N-065.000 Water Resources Atlas for the Park
GOGA-N-042.000 Lobos Creek Restoration, Protection and Management Plan
GOGA-N-006.000 Resolve Human/Natural Resource Conflicts

4.10.8 Data and Collection Management

The park's collection includes very few aquatic specimens. Basic aquatic inventory efforts will be required to establish reference or voucher collections. The collections will be composed of either properly preserved specimens or photographs and include supporting data. The description of these efforts is provided within the park's Collection Management Plan.

GOGA-C-010.000 Catalog Museum and Archival Collections
GOGA-C-029.004 Maintain and Upgrade Museum Collections — Manage Collection

Field data from park sampling activities, as well as those by non-NPS scientists, need to be stored in an accessible database. Currently, lists of aquatic species such as marine invertebrates, marine algae and plants, freshwater algae, freshwater and marine fishes, and sensitive species, are being maintained in a simple database. Possible future plans include providing the general public access to the data via the Internet. GIS support is required to link database to maps to show spatial relationships.

To accomplish these tasks, the biological, hydrological and physical science technicians would be responsible for maintaining collected field data and external data in park databases. The park aquatic ecologist and hydrologist would be responsible for ensuring linkage with the GIS program and quality control of databases. Collections will likely be added on an ad hoc basis, as a by-product of future inventory actions. Any contracts or cooperative agreements will include standards for the proper preservation and labeling of specimens.

Project statements related to aquatic data management include:

GOGA-N-014.000 Geographic Information System Development
GOGA-N-065.000 Water Resources Atlas for the Park
GOGA-N-065.001 Wetland and Aquatic Habitat Inventory
GOGA-N-081.000 Coho Salmon and Steelhead Preservation/Restoration
GOGA-N-029.000 Inventory and Monitor Aquatic Resources
GOGA-N-020.000 Inventory Marine and Estuarine Resources
GOGA-N-025.000 Monitor Marine and Estuarine Resources
GOGA-N-028.000 Water Quality Monitoring Program

4.11 Physical Resources Program

The park's physical resources include geologic features and processes, soils, water, air, weather, natural quiet and dark night skies. These provide the support for the diverse habitats and ecosystems within the park. They also affect the safety and enjoyment of park visitors. The physical resources program is focused on understanding, preservation, protection and sustainable management of these resources within the context of the park activities and environment. Water resources are primarily addressed under the Aquatic/Hydrology Program, above.

There are opportunities for cooperation with Interpretation, Facilities Engineering and Maintenance, Roads and Trails, and Resource Protection, as well as with the Presidio Trust staff. Assistance may be available through college and university programs, NPS regional support, Water Resources Division, Geologic Resources Division, and other agencies (e.g., USGS, National Oceanic and Atmospheric Administration/National Weather Service, Bay Area Air Quality Management District, California Division of Mines and Geology). The following projects are designed to improve physical resource management.

4.11.1 Erosion Control

Past land use practices have altered vegetative composition, aggravated and increased soil erosion, and have precipitated landslide activity and ongoing gully formation. These practices have contributed to increased sediment loads in streams and bays, the loss of large quantities of top soil, compaction of soils, prominent visual scars, and ongoing, recurring trail, road and facility maintenance costs. The worst and most obvious problems include trail and road erosion, grazing and riparian trampling, and gully formation.

The erosion control program should be expanded to address such issues as identifying potential slide and mass failure areas, rehabilitating roads, coordinating with the trail program, identifying areas causing sedimentation to park waters, and identifying impacts from grazing. Once soil erosion problems are identified, corrective measures can be implemented according to park priorities.

Project statements related directly to soil erosion include:

GOGA-N-002.000	Survey and Mitigate Erosion
GOGA-N-024.000	Range Management
GOGA-N-018.000	Monitor Beach Erosion
GOGA-N-008	Trail Planning and Maintenance
GOGA-N-077	Ecological Monitoring
GOGA-N-048.001	Stables Management

4.11.2 Coastal Processes

GGNRA's coastline is a resource of regional and national significance. The prevailing California current brings to the surface an upwelling of rich, deep, nutrient-laden water which provides for a highly productive environment for planktonic organisms. These conditions have led to a unique association of subtidal and oceanic species, including an exceptional assortment of algae, invertebrates, fishes, marine mammals and seabirds. The Gulf of the Farallones National Marine Sanctuary is adjacent to GGNRA's coastline and extends offshore 53 miles. A wide variety of sea life is protected in the sanctuary. The coastline is also included in the United Nations Biosphere Reserve. This is the only reserve which includes a coastal interface.

Threats to our coastline include oil spill contamination, water pollution, disruption of coastal dynamics, erosion, heavy recreational use, dumping and dredge disposal, and overharvest of marine resources.

A strategy for the protection of coastal resources will be initiated. Limited staffing has slowed the implementation of this project.

Project statements which relate directly to coastal concerns include:

GOGA-N-018.000	Monitor Beach Erosion
GOGA-N-025.000	Monitor Marine and Estuarine Resources

GOGA-N-028.000	Manage Marine Resources
GOGA-N-048.000	Establish Water Quality Monitoring Program
GOGA-N-046.000	Research Marine and Estuarine Resources

4.11.3 Physical Resources Monitoring and Protection

Programs to monitor and protect geologic features and processes, soils, water, air, weather/climate, natural quiet and dark night skies will be developed and implemented through the Inventory and Monitoring Program. Projects include:

GOGA-N-087.002	Restoring Ecosystem Function to Valley Soils
GOGA-N-033.001	Crissy Field Restoration Monitoring
GOGA-N-064.000	Physical Resources Monitoring and Protection
GOGA-N-040.000	Protection of Unique Serpentine Bluff Features
GOGA-N-065.000	Water Resources Atlas for the Park
GOGA-N-028.000	Manage Marine Resources
GOGA-N-006.000	Resolve Human/Natural Resource Conflicts

4.12 Geographic Information System (GIS) Program

The GIS program serves all park programs. GIS provides maps that are integrated with data points, enabling the user to have much information at his/her fingertips. Maps of different landscape topics such as vegetation and bird nesting can be overlaid together to give the user visual information that can assist in planning and management.

It is important that the GIS program be integrated and maintain a close link with the rest of the Information Technology Management groups in the park, specifically Information Technology Management Systems. Links to other ArcView users, CAD users and planners is also important. The GIS program has 5 elements: Hardware and Software, Data Development, Applications (Data Use), Training and Integration parkwide and GIS Planning.

4.12.1 Hardware/Software

GIS hardware and software has become less expensive, faster and easier to use in the last several years. Declining prices have allowed the GIS program to budget for equipment replacement and supplies without requests for additional funding. Also, based on past experience, the program has dropped maintenance contracts of all hardware and most software due to high cost. However, certain program items are still very expensive (plotters, remote sensing software, GPS receivers) and can only be obtained through special funding.

GPS and GIS software has acquired a friendlier interface and better integration with standard office software such as Adobe and MS Office products. GPS data retrieval is faster and more foolproof. The widespread use of ArcView software has enabled staff to browse available data as well as create needed data (though multiple data creators entail a greater need for data documentation and coordination).

4.12.2 Data Development

The programs for GIS use have recently become more abundant, more accurate and easier to acquire. ArcView allows staff to create custom maps, and the Internet allows for a wide variety of data free of charge. GGNRA coordinates with the USGS and other agencies so that the data are readily available. Local agencies are creating their own data for sale (San Francisco and Marin County base data) which provides more local information for our use.

The GIS program has shared data with Marin Municipal Water District, San Francisco State University, the County of Marin and state parks. This has led to reciprocal data trades or discounts on purchased data sets. GIS project money has funded data purchase and data development. A cooperative agreement with the USGS has led to more informal agreements for custom dataset development.

This quantity of data requires metadata (information about a particular dataset) to keep things straight. As of fiscal year 2000, metadata development will be necessary to request GIS funds from NPS sources. Regional data must have federally compliant metadata for parks to receive GIS funding. Metadata creation is a huge job and will require additional staff resources. One objective of this program is to begin having metadata entered into the system at the same time other data is being entered. This is the most efficient and accurate way for metadata to be accumulated for any particular dataset. A standard form and database will be developed to accomplish this.

Funding will also be contingent on regional contributions to the GIS data clearinghouse located on the Internet. This clearinghouse makes basic park data available to anyone with Internet access, and is part of a federal mandate to share publicly funded data.

4.12.3 Applications

Applications are the essence of the GIS program. Better software and data have widened the scope of possible GIS applications. A few examples include: habitat analysis, site suitability studies, viewshed analysis, fire program support, scenario modeling, and change detection. A pending application will link the extensive restoration database to ArcView to allow for report creation and map production from a wealth of field material.

Future availability of satellite imagery and improved sophistication of image processing software will make image analysis a more viable and time saving enterprise in the next few years. Hyperspectral imagery analysis will allow the park to target specific spectral signatures and remotely map plant locations as needed.

4.12.4 Integration

Integration, or the sharing of information, techniques and results is the final aspect of the GIS program. Integration takes on two forms: sharing the GIS information itself and sharing of GIS knowledge through teaching potential GIS users.

Integration of GIS information within the park can be well served by an internal web page (intranet) that houses park data along with a wide assortment of supplemental information to assist in understanding a particular project. This type of clearinghouse can also serve as an archive of projects as time goes on and will help with interdivisional communication. The parkwide clearinghouse will serve a similar function at a national level.

A future scenario of complete integration with adjoining agencies and stakeholders (GIS programs at Redwood National Park and Grand Canyon National Park) will be more achievable at GGNRA with improvements in personal and computer-based networking.

Integration of knowledge of how to use a GIS system occurs through the development of interns — seasonal and permanent employees who are required to enter data into the system as a part of their responsibilities. This is an ongoing program due to the lack of permanent assistance in developing the data within the GIS program itself. The GIS program relies on other park staff and volunteers to collect accurate data to add to the system.

4.12.5 GIS Planning

The development of a GIS Plan will best facilitate the growth of the GIS Program. Applications will be tied to a plan, which in turn is driven by resource/project needs articulated in project descriptions. A 5-year goal of the program is to develop such a plan and begin to implement it.

Project statements related to the GIS Program:

- GOGA-N-014.000 Geographic Information System
- GOGA-N-014.001 Geographic Information System — Vegetation Information Management Program
- GOGA-N-014.002 Geographic Information System — Linking ArcView to Restoration Database
- GOGA-N-014.003 Geographic Information System — Metadata Development

4.13 Research Program

Science is a valuable, ongoing part of the Natural Resources Management Program at the GGNRA. Through partnerships with the USGS Biological Resources Division, the Golden Gate National Parks Association and many academic and research institutions, the GGNRA reaches out to the broader scientific community to ensure that the most effective science can be attained in the park, given existing resources. The goal is to have reliable scientific information available for decision-making, problem identification, interpretation, planning and policy needs, at all levels of the organization.

A network of routine advisors and informal science partnerships have developed. At this time, contacts include: 23 aquatic specialists, 5 geology/soils scientists, 20 vegetation specialists, 69 wildlife specialists, a social scientist and an economist. These links allow for a quick assessments of issues at hand, and allow for a breadth of scientific support for the park, including such activities as conducting research, proposal development, and peer review of protocols and proposals. Additional linkages occur through the local environmental organizations such as the California Native Plant Society and the Audobon Society.

The USGS Biological Resources Division provides a research arm to the NPS and contributes resources to a variety of natural resources research in the GGNRA. The Golden Gate Field Station employs a full-time Research Ecologist, Judd A. Howell, Ph.D. He performs both park-sponsored research and assists the park with many research needs identified, through consultation. Dr. Howell is also an adjunct professor at Humbolt State University. Mike Saiki, Ph.D., with USGS Biological Resources Division, has developed proposals for several aquatic research projects at GGNRA. Roger Hothem serves as the research scientist evaluating black-crowned night herons on Alcatraz Island, as a biological indicator to the health of the San Francisco Bay. Gary Fellers, Ph.D., is assisting with bat and amphibian research in the park, and Erran Seaman, Ph.D., is assisting with the spotted owl research.

Currently research and collecting permits are handled through a joint program of the park's Special Park Uses Office, the Project Review process and the Natural Resources Management staff. The Special Park Uses Office handles the paperwork and tracking, the Project Review Process ensures appropriate review and compliance, and the Natural Resources Management staff serves as liaisons between the park and the outside scientists. The process is still new and developing.

The basic thrust of the 1998 National Parks Omnibus Bill, Title II, is acknowledging the importance of adequate, scientific information for decision-making in park management. It includes additional cooperative agreement authority that not only authorizes, but directs, the Secretary of the Interior to enter into agreements with colleges and universities. It also has a requirement to keep an administrative record of how resource studies have been considered in making decisions on actions that may adversely affect a

park resource, a requirement that the conditions of park resources be a significant consideration in superintendents' performance evaluations, and a provision that information on the nature and extent of sensitive resource information can be withheld to protect these resources.

Title II also mandates an inventory and monitoring program as well as research.

The following needs have been identified to implement the research section of the bill:

- Create a systematic method of requesting and documenting research needs, prioritizing and achieving them.
- Develop formal cooperative agreements with research institutions to allow for easier distribution of funds.
- Create an effective process to administer cooperative agreements, write grant requests, complete the Annual Investigators' Report, keep the project statements current, and update the Natural Resources Bibliography, issue and keep track of research and collecting permits and input GIS data into systems.
- Identify funding sources for science and research projects.
- Acquire technical assistance support for sampling design and statistical analysis.

The Research Program will be developed to fulfill these needs. A full-time science coordinator is necessary to begin the process. The coordinator would support staff and management needs in science by developing agreements with local research institutions, writing grants and assisting with funding projects and overseeing the Research and Collecting permit process.

Although many scientists are partnering with the park in small ways, formal agreements with a select group of research institutions will facilitate easier access to research. They will allow for exchange of funds and joint grant proposals. The science coordinator will research the various options, write the agreements, facilitate signatures and match up projects as necessary.

The program objectives are as follows:

1. To identify and evaluate the condition of biological species, habitats and natural processes in the park.
2. To inventory park ecosystems and to develop monitoring strategies that detect changes caused by natural and human sources. Once the initial monitoring protocol is established, management programs will be implemented.
3. To contribute to the definition of the park's natural resources issues and appropriate management of them.
4. To develop an understanding of the dynamic processes affecting the physical and biological resources of the park and their relationship to the cultural landscape.
5. To coordinate research with universities and other institutions.

4.14 Special Ecological Areas

A special ecological area (SEA) is the identified area in each ecological community type that is most biologically intact and diverse and in the case of grassland and lagoon in the park, represent the only example. SEAs are selected for their biological values. Communities currently represented include perennial grassland, coastal scrub, chaparral, oak woodland, redwood forest, foredune community, coastal strand community, serpentine grassland, riparian forest, estuarine community, fresh water pond community, aquatic stream community and the intertidal community. The creation of SEAs is not intended to discount the biological value of other natural resources zones within the GGNRA and does not exclude management activities in other park areas. One such area in each plant community will be designated to ensure the protection and maintenance of ecological diversity and processes.

The natural resources are the highest priority in these areas. Other uses, therefore, must be documented as having little to no impact on these particular ecosystems prior to use approval. Dogs, bicycles and off-trail hiking are to be excluded from these areas due to possible conflict with vegetation and wildlife. Equestrian use and park vehicle traffic are limited.

Management concerns such as non-native species control, erosion, and water quantity and quality, have a high priority for implementation in these areas. Emphasis will be made to expand this management into the buffer areas bordering SEAs.

Identified SEAs include:

1. The Wolf Ridge area between the Gerbode and Tennessee valleys for the perennial grassland and coastal scrub plant communities.
2. The northeast facing slope of Muir Woods National Monument redwood forest community.
3. Rodeo Lagoon estuarine community.
4. Bolinas Ridge chaparral community and oak woodland community.
5. Beach/Presidio serpentine and Bolinas Ridge serpentine (Cheda Ranch) for the rare serpentine grasslands which are the last refuges for many rare and sensitive native plant species.
6. Crissy Field dune community.
7. Baker Beach coastal strand community.
8. Redwood Creek aquatic, stream and riparian communities.
9. Intertidal communities in Slide Ranch (north end) and Bird Rock (in the Marin Headlands).

5 STAFFING PLAN FOR GGNRA NATURAL RESOURCE MANAGEMENT

5.1 Base Needs as Allocated by R-MAP

The National Park Service underwent a survey of values and threats to resources in 1994 to determine staffing needs based on quantitative analysis of resource values and threats. R-MAP identifies the workload associated with conducting a comprehensive natural resources management program. R-MAP's outputs are in full-time positions (FTE), although it is recognized that the need will not necessarily all be met with permanent NPS employees. Management ascertains the most effective and efficient combination of permanent staff, seasonal or temporary staff, and contracted labor to best meet the park needs.

The preliminary R-MAP analysis allocates a total of 49.4 FTE to conduct a comprehensive natural resources management program at GGNRA. This does not include the resource protection function which is projected by V-RAP. It also does not include the research function, except for science consultation and oversight. R-MAP identifies the workload associated with actually conducting the research needed by GGNRA to be 7.3 FTE. Under the DOI's current organization, this need will be met through USGS-BRD. In addition to the 49.4 FTEs, R-MAP allocates a division chief, four branch chiefs, and 7.5 FTE for clerical staff. These positions are distributed in the R-Map analysis as described below.

5.2 Staffing Organization

Through working with the recommendations of R-MAP, the following staffing plan is recommended:

DIVISION CHIEF: GS-13

Secretary: GS-5 (Serves Division Chief, Assistant Division Chiefs, & Science Advisor)

Clerk: GS-4; 0.5 FTE (Could be seasonal or part-time permanent)

Science Advisor: GS-13

Branch Chief, Vegetation Program: GS-12 (Terrestrial vegetation management, inventory and monitoring, disturbed area rehabilitation, and tree hazard management)

Secretary: GS-5

Plant Ecologist: GS-11 (Non-native plant control program supervisor: responsible for non-native terrestrial plant management and monitoring; restoration of non-native plant removal activities, responsible for planning and compliance issues related to exotic plant management)

Plant Ecologist/Botanist: GS-9 (Program leader, habitat restoration team: assists with native and non-native terrestrial plant management and monitoring)

Plant Ecologist/Botanist: GS-9 (Program leader, non-native plants — special plant leader: assists with native and non-native terrestrial plant management and monitoring)

Plant Ecologist: GS-09 (Program leader site stewardship)

Biological Technician: GS-07 (Habitat restoration team)

Biological Technical: GS-07 (Special plant leader)

Biological Technician: GS-07; 0.4 FTE (Agricultural/visitor use)

Plant Ecologist: GS-11 (Vegetation monitoring supervisor/vital signs — long-term monitoring: responsible for monitoring, vital signs, aquatic plants, rare plant monitoring)

Plant Ecologist: GS-09 (Plant ecologist, terrestrial plant long-term monitoring)

Plant Ecologist: GS-09; 0.5 FTE (Rare plant monitoring)

Plant Ecologist: GS-09 (Aquatic plant specialist: long-term monitoring)

Forester/Plant Ecologist: GS-11 (Vegetation management program supervisor: responsible for vegetation management, tree hazard management; responsible for planning and compliance issues related to tree hazard management, disturbed land revegetation)

Forester: GS-09 (Tree hazard management)

Forester: GS-07 (Tree hazard management)

Plant Ecologist: GS-09 (Fire ecologist and fire effects monitoring)

Biological Technician: GS-05; 0.4 FTE (Fire effects monitoring — seasonal)

Branch Chief, Wildlife and Hazard Management: GS-12 (Wildlife management, grazing management and fencing, agricultural use management, integrated pest management and hazardous waste management)

Secretary: GS-5

Wildlife Biologist: GS-11 (Terrestrial wildlife monitoring: responsible for native and exotic terrestrial animal monitoring and management; responsible for planning and compliance issues related to native and exotic terrestrial animal monitoring and management)

Biological Technician: 0.6 FTE (Wildlife monitoring — seasonal)

Aquatic Biologist: GS-11 (Aquatic species monitoring: responsible for native, TES, and exotic aquatic plant and animal management and monitoring; responsible for planning and compliance issues related to aquatic plant and animal management)

Biological Technician: GS-07; 0.8 FTE (Aquatic monitoring — seasonal)

Fisheries Biologist: GS-07; 0.8 FTE (Fisheries management — seasonal)

Wildlife Ecologist/Biologist: GS-11 (Rare species monitoring program leader: responsible for terrestrial TES animal management and monitoring; responsible for planning and compliance issues related to terrestrial TES animal management)

Wildlife Ecologist/Biologist: GS-09 (Rare species monitoring)

Biological Technician: 0.8 FTE (Rare species monitoring — seasonal)

Wildlife Biologist: GS-7/9 (Responsible for grazing management and fencing; disturbed lands)

Wildlife Ecologist/Biologist: GS-11 (Wildlife management program manager: responsible for integrated pest management, agricultural use management, and hazardous waste management; responsible for planning and compliance issues related to pest management, agricultural use management, and hazardous waste management)

Wildlife Ecologist: GS-09 (Non-native wildlife specialist)

Biological Technician: GS-07 (Non-native wildlife management)

Forestry Technician: GS-07 (Pig and other large animal management; pig fence maintenance)

Integrated Pest Management Specialist: GS-09 (IPM program coordinator)

Biological Technician: GS-07; 0.7 FTE (Integrated pest management — seasonal)

Wildlife Ecologist: GS-09 (Rare species management: works with park personnel and habitat restoration programs)

Environmental Protection Specialist: GS-7/9 (Assists with pest management, agricultural use management, and hazardous waste management) (Reports to Planning)

Branch Chief, Physical Sciences: GS-12 (Air, water and geologic resources management; planning and compliance, and collections and data management; also responsible for integration of all vital signs monitoring)

Secretary: GS-5

Hydrologist: GS-11 (Water quality program manager — responsible for water resources management; responsible for planning and compliance issues related to water resources management)

Hydrologic Technician: GS-07 (Water quality (freshwater))

Hydrologic Technician: GS-07 (Water quality management and monitoring (marine))

Hydrologic Technician: GS-07 (Water quality and water rights; water quality data collection — seasonal)

Physical Scientist: GS-11 (Geologic resources program manager: responsible for air resource management and geologic resources management; responsible for planning and compliance issues related to air and geologic resource management)

Geologist: GS-09 (Landfill and hazardous waste management)

Geologic Technician: GS-07; 0.6 FTE (Landfill and hazardous waste management)

Restoration Specialist: GS-11 (Disturbed lands program leader: responsible for disturbed area rehabilitation; responsible for planning and compliance issues related to disturbed area rehabilitation)

Geologist/Restoration Specialist: GS-09 (Other disturbed lands — assists with disturbed area rehabilitation)

Geologic Technician: GS-09 (Roads and trails rehabilitation)

Geologic Technician: GS-07 (Roads and trails rehabilitation)

Branch Chief, Resource Information and Communications/Data Management: GS-12

Secretary: GS-05

Geographic Information Systems (GIS) Specialist: GS-11 (Responsible for GIS)

Data Management Specialist: GS-11 (Responsible for other data management)

GIS Technician: GS-7/9 (Assists with GIS and other data management)

Natural Resources Interpreter: GS-09 (Center for resources interpretation: responsible for interpretation to resolve natural resource issues)

GIS Technician: GS-07 (Clerical and data entry support for GIS programming)

Curator/Librarian: GS-09; 0.7 FTE (Library and collections management — seasonal: responsible for natural resources collections and library cataloguing, curation, and care; assists with interpretation, planning, and compliance)

Natural Resources Management Specialist: GS-09 (Project review/environmental compliance: responsible for coordinating all planning and compliance activities)

Biological Technician: GS-07 (Assist with environmental compliance and project review)

Note: R-MAP allocates an additional 0.1 FTE to GGNRA for paleontological resources management. Rather than assign this responsibility as a collateral duty, it might be best to share a paleontologist position with one or more nearby parks (e.g., Point Reyes National Seashore).

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APPENDIX A

APPROACH TO NATIVE PLANT HABITAT RESTORATION

The step-by-step approach to native plant habitat restoration in the park is as follows:

1. **Evaluate Conditions.** The condition of natural resources in the park is evaluated on a watershed-by-watershed basis by an interdisciplinary team that includes the park's hydrologist, wildlife specialist, aquatic ecologist, ecologist, and vegetation specialist using an ecosystem approach.
2. **Prioritize Projects.** The highest priority for restoration work is given to regions where adverse conditions threaten special status plant or animal species, according to federal and state laws. The feasibility of implementing restoration is assessed, including budget constraints and political concerns.
3. **Plan.** In collaboration with other divisions, restoration goals and objectives are set. Site data are collected and a restoration action plan is written. Action plans include information on the amount of plant materials needed for restoration. This information is generated from field sampling data that quantifies the composition of the natural vegetation typically found in the surrounding area. The Project Review Committee reviews all restoration projects. Individual project statements will be written for restoration projects requiring special funding.
4. **Gather/Produce Plant Materials.** In adherence with the 1998 GGNRA nursery management guidelines and park propagation manual, plant materials such as seeds and cuttings are gathered and native plants are propagated in park nurseries. Propagation goals for each nursery are set annually according to specific restoration project requirements. Proper seed storage techniques are practiced in accordance with the guidelines. Careful record keeping through the park's restoration database allows for the tracking of plants from seed collection to propagation to outplanting so that methods can be refined, evaluated and improved.
5. **Site Preparation.** Sites/regions are prepared for restoration activities according to restoration action plans. This may involve erosion control, soil treatment, non-native plant removal or the installation of protective fencing and interpretive materials.
6. **Revegetate.** In adherence with the *Western Region 1993 Guidelines for Restoration in Disturbed Areas*, and following the schemes described in the restoration action plans, sites are revegetated with native seed and/or plants.
7. **Document.** All restoration activities are recorded on work performed/revegetation/nursery/monitoring data sheets and recorded in the park's restoration database.
8. **Maintain.** Follow-up maintenance activities are implemented and evaluated annually, and adjusted based upon the success criteria defined within the restoration project objectives. This is continued until the original (or modified) objectives are achieved. A sustainable level of maintenance activities is then determined.
9. **Monitor.** Photodocumentation is implemented for all restoration activities. For higher levels of monitoring efforts, field sampling protocols are outlined in GGNRA's Vegetation Monitoring Guidelines. If a new protocol is being developed to meet specific objectives, this must be peer-reviewed prior to implementation.

APPENDIX B

APPROACH TO NON-NATIVE PLANT MANAGEMENT

1. Monitor and Prevent New Introductions From Spreading into the Park

New introductions of non-native plants will be prevented by prohibiting the use of contaminated imported topsoil or fill, prohibiting the use of contaminated straw, ensuring that heavy equipment is cleaned before travelling between contaminated and non-contaminated regions, and continuing public education about the threats of non-native plants. Monitoring for the presence of new invasive non-native species is not currently done systematically, and is based upon available resources. Semi-annual monitoring for new non-native plants that could potentially enter the park's boundaries should be carried out. This will be achieved by establishing "survey corridors" such as roads and trails, park boundaries, new project areas, and other disturbed habitats. Park staff will also work with adjacent property owners to control non-native plants on their property, and work to create legislation/policy for prohibiting the sale of noxious plants.

2. Rank the Non-Native Plants of the GGNRA

The top 21 non-native plant species in the park have been determined according to their rate of spread, parkwide occurrence, formation of dense low diversity stands and feasibility of ongoing reduction and control. These species will be ranked during the next three years using a modified version of the analytical procedure outlined in the *Handbook for Ranking Exotic Plants for Management and Control* (Holmes, unpublished Natural Resources Report NPS/NRMWRO/NRR-93/08). Modifying the ranking will require collecting additional data and the review of past data and current literature. Employing this system will ensure that ecological knowledge and complete information are applied to the decision-making process. Based on this system, the greatest control efforts will be directed toward the highest ranking threats.

3. Map Distribution of Important Non-Native Plant Species

GGNRA began surveying and mapping invasive species in 1987. Invasive species surveys and maps serve as an inventory from which managers can identify size and location of a specific weed infestation, track the rate of spread of a species and prioritize and plan for species removal. In 1987 the cover of non-native invasive plants in the Marin Headlands was 135 acres (approximately 1 percent of the total area). Today, one species alone—Cape ivy—dominates more than 67 acres. Populations of eucalyptus, Monterey pine and Monterey cypress were re-mapped and surveyed in 1998. Now 210 stands of these invasive tree species cover 315 acres, approximately 2 percent of the land base. It is estimated that the current total cover of targeted non-native invasive plants in the Marin Headlands is more than 10 percent.

Comprehensive parkwide surveys of targeted species are critically important in prioritizing control efforts. Detailed information is available for approximately 70 percent of the park. Hand-drawn and electronic maps and non-native species surveys have been completed for most units. These data need to be consolidated and reviewed for accuracy. Additional surveys must be completed in watersheds north of Stinson Beach and south of Milagra Ridge. These regions are less visited than the rest of the park and support some of the most intact assemblages of coastal scrub, chaparral and grasslands. Detailed surveys and maps of the current invasive plant threats in these regions are essential.

4. Develop Control Methods for Widespread Target Species

Critical to determining the most appropriate control and/or removal methods for the park's invasive non-native plant species is the collection of biological and ecological information (including identification of patterns of spread, reproductive trends, mature plant biology, etc.), reviewing past literature, and evaluating the effectiveness of the park's current adaptive management control strategies for each species. The completion of these steps has only been undertaken for one species — Cape ivy, the park's highest priority threat. Components of this strategy have been completed for French and Scotch broom, oxeye daisy, eucalyptus, capeweed, cotoneaster, thoroughwort, tall fescue and harding grass. Additional resources are required to complete the necessary research and data collection/evaluation for the park's remaining targeted invasive non-native species.

The compilation of the data/information described above has led to, or will lead to the development of an Integrated Pest Management approach for each species, and a plan of action including treatment alternatives. This information will be summarized in the park's restoration database. Comprehensive files on each species are kept in the Natural Resource Center at Fort Cronkhite.

5. Conduct Research and Review Literature

Critical to a successful integrated management strategy for invasive non-native species is acquiring an ecological understanding of each species, and its ability to respond to particular environmental conditions based upon life history, special adaptations, and ranges of tolerances. Management priorities must be determined based upon ecological criteria and project feasibility. Most of this knowledge is acquired through continued research and adaptive management. GGNRA has conducted and/or participated in several non-native species research projects, focussing primarily on French broom and Cape ivy.

In 1994-1995 GGNRA hosted a California Exotic Pest Plant Council working group on Cape ivy which conducted experiments on its biology and experimental removal methods. A combination of herbicides is more effective at controlling Cape ivy in a eucalyptus forest than hand removal methods; the application of a solarizing layer of clear plastic was unsuccessful in this setting (Bossard and Benefield 1995). A master's thesis on the negative impact of Cape ivy on three plant communities in the park was conducted in 1996-1997 (Alvarez and Cushman 1997) and a study of its effects on the abundance of insects for two watersheds was completed in 1997 (Fisher 1997). Research is currently underway to improve the understanding of the dynamics and consequences of French broom invasion into coastal grassland habitat.

Given the current vegetation program's resources, the majority of invasive non-native species research needs remain unmet. Baseline scientific information on the dispersal mechanisms, life history, ecological impacts, and responsiveness to varying control techniques is still needed for approximately 50 percent of the top 21 invasive non-natives within the park.

6. Implement Small-Scale Pilot Projects and Adaptive Management Trials for New Control Treatments/Invasive Species

Invasive non-native plant removal/containment pilot projects will be implemented whenever possible and/or feasible. Past pilot project implementation has been critical for determining treatment cost, and effectiveness. Pilot projects, on varying scales, have been implemented for the control of the majority of the park's 21 priority invasive threats. The effectiveness of each

pilot project and planned control technique is systematically tracked, monitored, and evaluated. Test variations of pre-determined prescriptions in different environments are also implemented to refine control techniques.

To accomplish these and other invasive non-native plant program objectives, the vegetation program works in partnership with the California Exotic Pest Plant Council, the California Native Plant Society, the University of California at Davis and other local colleges, universities and conservation agencies to stay current with the latest knowledge about the ecological impact of invasive non-native plants on native plants and animals, the rates of spread into different habitat types, and the development of more efficient control methods that would strengthen GGNRA's control program.

7. Control High-Priority Localized Populations

To date, approximately 90 percent of the vegetation program's invasive plant control resources have been targeted on approximately 50 percent of the park's land. Priorities and resources have been established based upon ecological parameters, political climate, and centralized human resource availability. The process for this priority setting has not been consistent, or based upon a full knowledge of targeted invasive plant threats. Therefore, staff have been unable to prioritize future management actions effectively. However, once baseline data collection is completed, the park will have a parkwide GIS database of targeted invasive non-native plant species which can be used to prioritize future control efforts and evaluate long-term rates of spread for key species.

Priority containment and removal sites will be identified for each major watershed based on the agreed-upon criteria and ranking. Where targeted invasive non-native plants occur on non-federal lands and are a threat, coordination with land owners will be attempted to maximize control success.

The implementation of invasive non-native plant control projects are conducted primarily by vegetation stewardship program participants. All control efforts are documented and monitored.

8. Educate the Public and Coordinate with Other Agencies

Presentations and training on non-native plant management are given to park employees and the public. Site bulletins describing the biology and control methods of important pests are being developed. In addition, park employees and volunteers are urged to participate in the California Exotic Pest Plant Council. The GGNRA has taken an active role in its working groups, including the pampas grass, French broom, and Cape ivy working groups.

APPENDIX C

APPROACH TO RARE PLANT MANAGEMENT

1. **Compile and Disseminate Information to Gather Baseline Data for Management Priority Setting and to Educate Park Staff**

Rare Plant Management Guidelines were developed in 1985 for 23 rare plant species. In 1992 historic populations were resurveyed. The guidelines were then revised in 1994, and included current information on the then 31 rare plants. Guidelines were disseminated throughout the park to both educate park staff, and to prevent incompatible use in the habitats supporting these species. The guidelines include the following information for each species: blooming calendars, specific location maps for each population, a photograph and line drawing, general distribution, a description of the plant, habitat description, existing endangerment factors, management recommendations and a list of information available in the natural resource file. The guidelines are currently being revised to include the now 38 rare plant species.

2. **Monitor Populations**

Of the 38 special status species in the park, 23 were documented during surveys conducted in 1985. Additional monitoring of rare plants in the Presidio has been conducted annually since 1993. These monitoring efforts have been conducted by California Native Plant Society volunteers, community stewards and park staff, and have provided valuable information on plant species distribution, population size, and trends. Additionally, 6 species were monitored in the northern lands in 1994. Not all taxa, however, have been monitored systematically every year, and numerous new taxa have been added to GGNRA's rare plant list since 1984. In 1998 a parkwide censusing program was implemented and 30 species (including those on the Presidio and in the northern lands) were monitored. This effort involved funds from the Golden Gate National Parks Association and more than 1,600 volunteer hours. In 1999 rare plant censusing efforts expanded to include the San Francisco watershed lands. Seven species, however, still have not been fully censused, and no monitoring efforts have been conducted in the Phleger Estate. Baseline information on population sizes and trends for many of these plants is limited, and has been gathered for less than 5 years.

Surveying for New Populations

Comprehensive field surveys of suitable habitat often result in the discovery of additional populations of known rare plants, which may indicate the species was not as rare as previously believed. Additional surveys may also result in discovery of rare taxa that have not been documented previously in the park, or taxa that have not been previously seen or described at all. In the former case, this information may preempt the need to list a plant; in the latter case, the information ensures that plant taxa that have never been documented are not becoming extinct.

The implementation of a rigorous floristic inventory of vegetation communities that could potential support rare flora is contingent upon funding of a larger comprehensive rare plant management program (GOGA-N-009.000).

Census Taking and Estimating Population Sizes

The 1994 edition of the *Rare Plant Management Guidelines* predicted the censusing needs for each species. It outlines a schedule, census frequency, intensity and timing for each species. The census protocols are compatible with the statewide California Native Plant Society rare plant census protocols, and all data are sent to the CDFG annually.

Effective management of special-status plants requires systematic information on population size fluctuations, as well species ecology and habitat requirements. Without consistent funding to gather this information in a comprehensive manner, resource managers are unable to determine whether a plant population or species is stable, increasing, or decreasing in areal extent or abundance. In 1995 vegetation program staff concluded that the current census methods (noted in the 1994 edition of the *Rare Plant Management Guidelines*), while tracking range and approximate population size, did not adequately determine habitat associations, or track population size and distribution. Efforts are underway to work with local universities to develop a suite of statistically valid monitoring protocols for each guild of rare plants. Current resources have only enabled staff to create a protocol for monitoring annual species, which was field-tested on populations of the San Francisco lessingia. However, in the interim of developing valid monitoring protocols, the vegetation program is censusing all rare species annually to potentially detect gross patterns and trends in rare plant population size. This information will then be used, coupled with more scientifically sound monitoring data, to develop acceptable thresholds of change (e.g., if plant numbers or areal extent of a particular taxon declined by 10 percent or more, management actions would be triggered).

3. Protect Against Impacts

Sixty percent of the park's rare plant habitats are protected against impacts caused by non-native plant invasion, trampling, maintenance activities and fire suppression. Sensitive species that exist in areas subject to trampling by hikers or dogs are fenced. Maps detailing the ranges of all known populations of rare species are provided to the park's compliance branch to ensure that no park activities are incompatible with rare plant management. In 1998, the park's largest rare plant restoration project, Lobos Creek Dunes, completed construction, and interpretive signage, wayside exhibits and boardwalk through the restored habitat will hopefully promote increased public awareness and sensitivity toward the park's rare resources.

Although most of the rare plants occurring within the boundaries of the park are protected from incompatible land use, such protection, in and of itself, does not ensure the recovery and persistence of endangered plant populations. It has been established that after populations are protected from human disturbance, some populations require management to slow, and eventually reverse, their decline (Pavlik 1987). Of particular importance are data on population trends (stability, growth, or decline) and reproductive performance. These data enable managers to determine appropriate management strategies, or adapt existing strategies to protect populations and species at risk of extinction. Detailed, species-specific information on habitat requirements, historic range, mode of reproduction, pollination vectors, and population dynamics also are baseline requirements for any attempts at reintroduction of special-status plants. Additionally, a detailed analysis of the current threats to natural population expansion must be assessed.

4. Research and Literature Reviews

Effective management of these species-at-risk requires information on the basic ecology of the species. Distribution patterns, habitats, and ecological parameters differ for each species. Limited

past management activities have provided insight into assessing ecological requirements, as well as ecological opportunities and constraints for species. Some species require active dune blowouts to colonize, some are dependent upon frequent burning, while others prefer a specific microenvironment for optimal population size and vigor. Timing, intensity, and frequency of a proposed activity are key factors in biological evaluations for proposed management activities. To effectively protect existing populations and, if necessary, propagate or reintroduce rare plants to new areas, vegetation program managers require information on the ecological requirements and the life history characteristics of the managed species.

GGNRA has conducted and participated in several rare species research projects, focussing primarily on the federally endangered Presidio clarkia and San Francisco lessingia. In 1997-1998, two San Francisco State University students conducted studies in the Presidio dune communities. One study completed a comparative baseline study of invertebrates at sites within the restoration areas and outside of the restoration activities, comparing relative abundance and species diversity (Lacabanne 1998). The second study examined the negative interaction of non-native grasses and the San Francisco lessingia (Pogge 1998). Current research includes an analysis of the microhabitat requirements for establishment of the Presidio clarkia in restored serpentine grassland habitat.

Given the current vegetation program's resources, the majority of rare plant species research needs remain unmet. Baseline scientific information is still needed for approximately 95 percent of the park's rare plant species.

5. Enhance Rare Plant Populations

Approximately 40 percent of the Vegetation Stewardship Program's field restoration activities are targeted toward the goals of rare or endangered species habitat enhancement and protection. Eighty percent of these efforts are accomplished on the Presidio through the Presidio Park Stewards. Staff and volunteers conduct annual population size estimation/censuses and range mapping for all 12 rare species found on the Presidio. They also conduct research projects that guide management actions for species enhancement (e.g., *Clarkia franciscana* seeding experiment (1998–1999), *Lessingia germanorum* sampling method determination (1998); collect of seeds from rare plant species for direct seeding or propagation (at the Presidio Native Plant Nursery) and outplanting into suitable habitats (in consultation with the U.S. Fish and Wildlife Service, when appropriate); and remove invasive threats. In total, sand dune habitat supporting 5 rare or endangered species has been increased by 31 acres, serpentine grassland habitat supporting the federally endangered Presidio clarkia has increased by 6 acres, and serpentine chaparral habitat supporting 4 rare species has increased by approximately 6 acres through the program's efforts. Habitat enhancement efforts for the Franciscan thistle are underway on the Presidio and in the Marin Headlands. Research efforts include evaluating habitat requirements and identifying areas of re-introduction. Seed and cutting collection and propagation trials have been successfully conducted for 6 rare plant species.

6. Recovery Plan Implementation

The Vegetation Stewardship Program is currently implementing recommendations outlined in the Raven's Manzanita Recovery Plan. The U.S. Fish and Wildlife Service is currently finalizing two additional Recovery Plans which affect 10 rare park species including: Presidio clarkia (*Clarkia franciscana*), Marin dwarf flax (*Hesperolinon congestum*), San Francisco lessingia (*Lessingia germanorum*), San Mateo thornmint (*Acanthomintha duttonii*), Tiburon Indian paintbrush (*Castilleja affinis* ssp. *neglecta*), fountain thistle (*Cirsium fontinale*), white-rayed

pentachaeta (*Pentachaeta bellidiflora*), San Mateo wooly sunflower (*Eriophyllum latilobum*), Crystal Springs lessingia (*Lessingia arachnoidea*) and beach layia (*Layia carnosa*). Recovery actions in the plans include researching the species' life histories and their ecological and population parameters, as well as removing and preventing direct threats to the populations. Recovery actions also include investigating the need for establishing additional populations in suitable habitat areas. The draft plan for endangered species found within San Francisco dune communities stresses the need for identifying areas that would be ecologically appropriate for potential introduction of *Lessingia germanorum* in historic localities as well as sites for introduction at Fort Funston. For the Presidio clarkia and Marin dwarf flax, the plan also suggests management guidelines be developed to address the potential for reintroduction.

Current resources only provide for continued rare plant restoration work on the Presidio. Implementation of the larger proposed rare plant program for the park (project statement GOGA-N-009.000) will enable the park to meet the obligations outlined in the Recovery Plans, plus address the recovery needs of species that currently do not have plans.

7. Reintroductions

GNRA's rare plant program includes the reintroduction of rare or extirpated plant species into the park when deemed ecologically appropriate. Vegetation Stewardship staff has developed an approved document format for reintroducing flora. The format includes an evaluation of historical information on population range, monitoring strategies, ecological appropriateness, propagule availability and locations, maps and permit requirements.

Twenty-six species are proposed for use in the re-creation of a tidal marsh at Crissy Field on the Presidio of San Francisco. These species, once found in marshes along the city's shoreline and throughout San Francisco Bay, have been extirpated as tidal marshes have been destroyed during the past 150 years. Several nearby tidal marshes will serve as a source for seeds and propagules. The historic presence of an extensive dune-tidal marsh complex suggests that this site provides unique opportunities to restore a floristically diverse sandy tidal marsh. One species is the federally endangered California seablite.

Calystegia soldanella and *Lathyrus littoralis* have been reintroduced at Crissy Field and Baker Beach on the Presidio of San Francisco. *Lathyrus littoralis* is absent from the Presidio at present; the only extant population in San Francisco is a small colony below the Great Highway at Fort Funston.

APPENDIX D

SYNTHESIS OF EXISTING VEGETATION MONITORING PROGRAM

1. Site Evaluations, Work Performed Sheets, and the Restoration Database

Each time habitat restoration work is done in the park a work performed sheet is completed and the information is entered into the Restoration Database. This provides the park with an ongoing record of all vegetation work done by resource managers and stewards, referenced by subwatershed. In addition, this provides a forum through which the park's vegetation activities, from rare or endangered native plant enhancement to aggressive non-native plant control, can be regularly evaluated by staff and volunteers.

2. Photomonitoring

With some exceptions, each restoration area is photographed before, during, and after major restoration projects. A standard protocol for photomonitoring has been developed and all data records are stored in the Restoration Database. Future efforts will include storing key photographic images in electronic files, which will also be linked to the Restoration Database.

3. Mapping

Mapping of vegetation is done on many scales, and on varying levels of detail within the park. Increasingly, mapping in the park is being done with geographic information systems (GIS) software that can manipulate, analyze, and display mapping data. Current data layers include targeted invasive non-native species populations (50 percent completed), rare flora (90 percent completed), restoration planning and implementation areas (80 percent completed), watershed and subwatershed boundaries (100 percent completed), and vegetation communities (85 percent completed).

4. Outplant Survivorship Monitoring

Over the last seven years, native plant nurseries have become an integral component of GOGA's habitat restoration projects. The five park nurseries have grown more than 500,000 plants from more than 100 species that have been planted into restoration sites. The result is an increase in the cover, abundance, and diversity of native plants, reducing the competitive advantage of invasive weeds. In order to assess the contribution that nurseries, and direct planting are making to restoration efforts, and to assess the relative success of outplanting among restoration sites in varied habitats, an outplant survivorship monitoring program has been designed. Data records are stored in the Restoration Database. Also see the revegetation section under Native Plant Nursery Program.

5. Vegetation Assemblage Monitoring in Re-Created Dune Sites

Much of the habitat restoration that occurs in the park involves working within a degraded habitat to protect and enhance the existing native flora and associated ecosystem features. In two dune sites on the Presidio, however, restoration projects have involved importing sterile sand to re-create native dune habitat. At the Lobos Creek Dunes and Feral Dunes more than 50 species of native plants, including five California Native Plant Society listed rare and endangered species, have been planted or seeded over the past four years. Beginning in year three of the project at Lobos and year one at Feral Dunes, a monitoring program has been conducted to describe the

changes in the composition of the plant community and to track the change in cover of several important dune species. Through working with an ecological design consultant, park managers developed a quantitative monitoring protocol that will allow for the assessment of plant cover data for several indicator species. The average cover of the rare plants and of potential dominant shrub species was compared among planting and seeding zones, soil types, and different slopes and aspects. This information is assisting managers and stewards assess the relative success of re-creation efforts and will help determine planting and seeding mixes for future dune restoration or re-creation projects.

6. Rare Plant Monitoring

One of the primary roles of vegetation management in the park is the protection and enhancement of rare or endangered species. Over the years, managers and stewards have improved statewide California Native Plant Society methods for tracking the range and size of populations of the rare plant species that occur in the park, and the restoration efforts intended to enhance them. These data allow for the assessment of the success of management actions and ensure that managers and stewards are apprised of any dramatic changes in population size or range that might necessitate immediate action (see Section 4.6.3, Rare Plant Management, for more details).

7. Endangered Mission Blue Butterfly — Associated Vegetation Monitoring

As part of the monitoring program (see Section 4.4, Wildlife Program) for the mission blue butterfly (*Plebejus icarioides missionensis*), the GGNRA has been conducting vegetation sampling in all mission blue butterfly habitats. The goal of the vegetation sampling is to assess the cover of host plants, nectar plants, and other vegetation and substrate features in the areas where the butterflies occur. It is thought that correlations between the abundance of butterflies and vegetation characteristics may assist restoration planning to ensure the long-term health of the butterfly in the GGNRA.

A second vegetation monitoring program was initiated in 1998 to track the potential impacts of an aerial pathogen on the mission blue butterfly's host plant (*Lupinus albifrons*). This program is administered parkwide and the sampling design was developed through consultation with the U.S. Fish and Wildlife Service, a biostatistician and a plant pathologist.

Future mission blue butterfly habitat restoration efforts at Fort Baker will include the establishment of permanent vegetation and butterfly transects in degraded habitat proposed for restoration. These transects will be monitored annually to determine correlations between the conversion of vegetation types, plant species composition and the presence/absence of butterflies.

8. Seed Collection from Native Plant Species

With the scale of the park's restoration program increasing several-fold over the past decade, it has become important to track the collection of seeds from specific habitat types and locations. The park policy on the collection of seeds is that no more than 5 percent of the seeds from any population can be collected in a given year. With some species being locally or globally rare, the possibility of over-collecting has become real. To avoid over collection, a monitoring method utilizing maps of field sites and a seed collection data sheet has been developed to track this information. This feasibility and effectiveness of this method is being evaluated on the Presidio. The data sheet provides a format for collecting information that will allow for comparison of seed quality (i.e., germination of the seeds in the nursery) from different sites and from seeds collected at different times of the year.

9. Vegetation Community Classification

As part of the Vegetation Mapping Project on park properties nationwide, and as part of the California Native Plant Society's efforts to classify California vegetation (for inclusion in the *Manual of California Vegetation*), GGNRA staff, contractors, and volunteers have been collecting species richness and vegetation structure data for each vegetation community type in the park for two years. At each of 138 polygons identified as containing distinct vegetation (by aerial photography), information has been collected on the vegetation and associated site characteristics. Staff are currently completing an accuracy assessment of the classification data. The information gathered as part of this project enhances the GGNRA natural resource inventory and will serve as baseline data to monitor any large-scale future changes in community type or species cover.

Appendix A

Approach to Native Plant Habitat Restoration

Appendix B

Approach to Non-Native Plant Management

Appendix C

Approach to Rare Plant Management

Appendix D

Synthesis of Existing Vegetation Monitoring Program